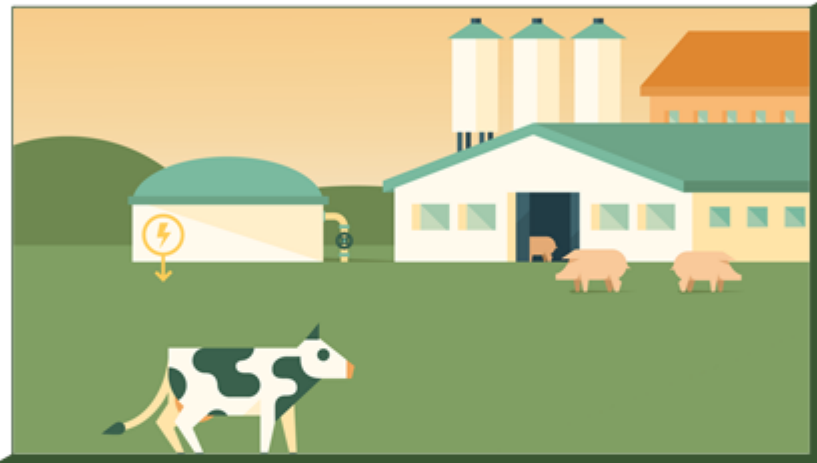

Implementation Guide For Small-Scale Biogas Plants

A farmers handbook

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www.bioenergyfarm.eu

CONTENT

Introduction

To conserve finite fossil fuels and to simultaneously reduce greenhouse gas emissions and mitigation of global warming a gradual switch within renewable energy sources is a necessary task in the next decades. Here bioenergy plays a central role - also for agriculture branch. Bioenergy is a largely CO_2-neutral energy source and it is permanently renewable, as it is produced out of biomass, which is actually a living storage of solar energy through photosynthesis.

The production and utilisation of biogas has a special role within the renewable energies, because it is suitable for the simultaneous production of electricity and heat, useable as fuel for transport and as a substitute for natural gas. In addition, it can be used flexibly and relatively simply stored. And the biogas production is not subject to seasonal, diurnal or weather-related fluctuations and can also be generated from agricultural residues and leftovers. The production and utilization of biogas provides environmental and socioeconomic benefits for the society as a whole as well as for the involved farmers. Utilization of the internal value chain of biogas production enhances local economic capabilities, safeguards jobs in rural areas and increases regional purchasing power. It improves living standards and contributes to economic and social development [SEADI ET AL 2008].

Also the worship of environmental soundness and sustainability in the agriculture, especially in livestock farming, is becoming more and more important. The carbon footprint of meat, milk and related products is high compared to vegetable food. One of the main reasons is the emission of methane by cold digestion of the manure produced by the animals. A good solution to reduce the emission of methane is to produce biogas out of the manure in biogas installations. Therefore more and more farmers are interested in connecting manure utilisation and climate protection intelligently by using biogas technology.

In most European countries the biogas sector started by digesting manure in combination with coproducts like maize, wheat, grass, etc. which can also be used as feed for animals. The food vs. feed discussion is an important issue, so the implementation of co-digestion is decreasing sharply e.g. in Germany, Belgium and the Netherlands.

The EU-Project "BioEnergy Farm II - Manure, the sustainable fuel for the farm" aims to provide practical guidance to farmers to produce biogas on farm based scale in small biogas plants and at the same time contributing to farm income and delivering environmental friendly energy. The handbook was created to support farmers interested in implementing a small scale biogas plant on their farm.

The BioEnergy Farm II-Project

The motivation behind the EU-Project "BioEnergy Farm II - Manure, the sustainable fuel for the farm" is, to promote on-farm production of renewable energy from small-scale anaerobic digestion, which mainly uses manure and agricultural residues of the farm.

The project will help to improve the public opinion about agricultural biogas production and will contribute to make livestock farming more sustainable by producing on-farm energy for self-sufficiency or feed-in, reducing emissions, improving manure as farm-fertilizer (closing nutrient cycle) and generating agricultural added value. The project is based on the observation that, despite its multiple benefits, small scale biogas plants are not yet widely implemented in European livestock farming, or its implementation varies extremely between the European member states.

The aspects the BioEnergy Farm II project treats are manifold; it will inform farmers, policy makers and other interested parties about existing concepts for micro-scale biogas plants with a market overview incl. an estimation of market potential of micro scale biogas plants in Europe. In addition to the creation of this manual for the development and execution of a biogas project, the project will furthermore assist farmers by checking the feasibility of a micro-scale digester for their own farm. Within these feasibility studies, different ways of biogas utilization can be analysed, like

producing electricity and heat with a CHP installation, gas upgrading to be fed into gas grids, producing heat in a biogas boiler or for biogas upgrading to generate natural gas substitute e.g. to be used for transport fuel. To improve the profitability of micro-scale installations, the treatment of the digestate to improved fertilizers quality will be taken into account as well. Manure processing will further increase the sustainability of livestock farming, besides the environmental benefits of the production of biogas and the reduction of greenhouse gas emissions from manure storage. The project will also outline implementation barriers regarding legal and financial framework and identifies improvement options for the development of manure based biogas production by on-farm micro-scale digester to farmers and policy makers, too.

The major outcomes and deliveries produced and published as part of the project, in order to support implantation of small-scale anaerobic digestion are:

- "Market overview of micro-scale biogas plants in European countries"

  The report presents a European market overview on small-scale anaerobic digestion, presents best practice examples and an estimation of market potential in Europe.
- "Guideline for policy makers on how to promote micro-scale biogas production"

  The guidance document for policy makers introduces the biogas technology by small-scale plants, describes the environmental and socio-economic benefits and gives an overview on legal framework conditions for micro-scale digesters in Europe as support for legislative improvement measures.
- The farmer's handbook "Implementation guide for small-scale biogas plants"

  This guideline presents the basics of biogas production and utilization and describes the essential steps for developing a biogas project (from the idea to plant operation).
- Online calculation tool

  A decision support tool for farmers and other interested parties which is available online (free of charge). It allows the user to run a general examination on the general conditions and the (economic) feasibility of a biogas plant for its farm.
- Expert-Workshops

  Organised Workshops to train agricultural consultants (project-participating and non-participating European countries) on small-scale biogas plants and the use of the expert calculation tool in order to support farmer who are interested to implement a small-scale biogas plants.
- Expert calculation tool

  A detailed feasibility tool (offline version) which will be used by the trained experts to perform feasibility scans with the farmer on his particular project/farm conditions. The data of the offline scans will be used as input for the business plan of the small-scale digestion project.
- Project web side

  The portal "www.bioenergyfarm.eu" provides e.g. information on small scale biogas technology, compiles all project related information and publications and calculation tools. It also provides a calendar with the schedule of the workshops and other relevant events on this topic.

The consortium of BioEnergy Farm II includes representatives from agricultural organisations (Institute for Agri Technology and Food Innovation (DK), Association for Technology and Structures in Agriculture (DE), Cornelissen Consulting Services (NL), Farmers Association Projects (BE), University of Turin (IT), National Energy Conservation

Agency (PL), TRAME (FR)), which will contribute knowledge and information in their respective areas and farmers experts & consultants (Coldiretti Piemonte (IT), DCA Multimedia (NL), IBBK Fachgruppe Biogas GmbH (DE), Foundation Science and Education for Agro-Food Sector (PL), Organic Denmark (DK), Regional Chamber of Agriculture of Brittany (FR)) who will mainly show farmers the feasibility of micro-scale digestion and the first steps of how to implement it. The consortium does not include any biogas technology supplier or sellers of biogas plant components.

The BioEnergy Farm II project recognizes the efforts in several European countries in small-scale biogas plants, using only on farm biomass resources for energy production. In that way the project contributes to an enlargement of this particular biogas technology throughout European countries, by transferring essential knowledge among European member countries and decision makers at all levels to increase awareness of the potential of small-scale biogas plants. This should consequently encourage the political environment to provide sufficient incentives that ensure an enlargement of this more sustainable renewable energy technology.

Aim and content of the implementation guide

Essential for a successful biogas project realization is among others a (practical) long-term view, a good organization and fulfilled technical conditions. To make sure that the anaerobic digestion plant is profitable in long term, the project has to be well planned.

This handbook was written within the EU-Project "BioEnergy Farm II - Manure, the sustainable fuel for the farm" and sets its main focus on small-scale (also called micro-scale) anaerobic digestion plants, running on farm based agricultural side products and residues with an power production capacity from up to about 100 kW_{el} (depending on the countries frame conditions). The publication "Market overview of micro-scale biogas plants in European countries" provides information on county specific definition of small-scale biogas plants for project-participating and non-participating European countries (visit www.bioenergyfarm.eu).

This handbook was created to support farmers and interested parties who are interested in using farm related biomass resources for producing a more sustainable renewable energy and are willing to invest in a small scale biogas plant on their farm.

The guideline describes the essential steps for developing a biogas project, beginning with the project idea, over creating a business plan until the final step of plant operation. The handbook starts with a short introduction into the biological biogas production, types of gas utilisation and digestate treatment and gives some general information about realizing a project (Figure 3 gives an overview on the main steps that the farmer has to fulfil to make the project becoming real, profitable and lasting). This is followed by the five main steps of project implementation which are outlined in separate chapters. It makes no claim to be complete. Additionally, certain frame conditions may demand modifications from the proceedings presented in this guide.

The attachments of the handbook also contain general information and country-specific information which are important for the project realization.

The annex 1 shows and describes different types of contracts, e.g. for plants construction or external heat supply to purchasers, which might be necessary for realising a bioenergy project and operating a biogas plant.

The following annex 2 provides a checklist for developing the "project idea" and also for the compilation of documents for permit application.

And the annex 3 contains country specific information (for the countries represented in the consortium only) on types of legal forms of agricultural businesses, proceeding of permits and emission regulations for small-scale biogas plants and actual subsidy regulations. This chapter also provides a list with publications and further information an agricultural

biogas production and utilisation in available in each country as well as contact details of relevant institutions for information and consulting on this matter.

The information in this general version of the handbook represent the state of February 2015. The country-specific versions of the farmer's guideline focus on the national framework conditions and are regularly updated to reflect the current state.

1. Biogas – an introduction

1.1 Basics of biogas formation

When organic matter (biomass) is degraded in the absence of oxygen (anaerobic) by microbiological processes, various gases are formed. This gas mixture produced by anaerobic digestion is also referred to as biogas. Digestate is a by-product of the fermentation process. The digestate which results from the anaerobic digestion process is a decomposed substrate, rich in macro and micro nutrients and therefore suitable to be used as plant fertilizer.

Anaerobic digestion is perfectly eligible for agricultural activities since energy crops (e.g. maize, whole grain crops.), organic residues (e.g. manure), side products (e.g. fruit pomace, oil seed leftover) and organic wastes are efficient substrates available or produced on farms.

Biogas consists essentially of methane (CH_4) and carbon dioxide (CO_2) and additionally of hydrogen (H_2), hydrogen sulphide (H_2S), ammonia (NH_3) and other trace gases. The biogas composition is mainly influenced by the substrates used for digestion and the fermentation processes itself. The type of substrate or substrate mixture primarily determined the biogas condition.

The process of biogas formation basically runs in four microbiological steps which are temporally parallel (see Figure 1). For a smooth process the individual degradation phases have to be optimally balanced to the requirements of the bacteria involved (e.g. pH-value, temperature).

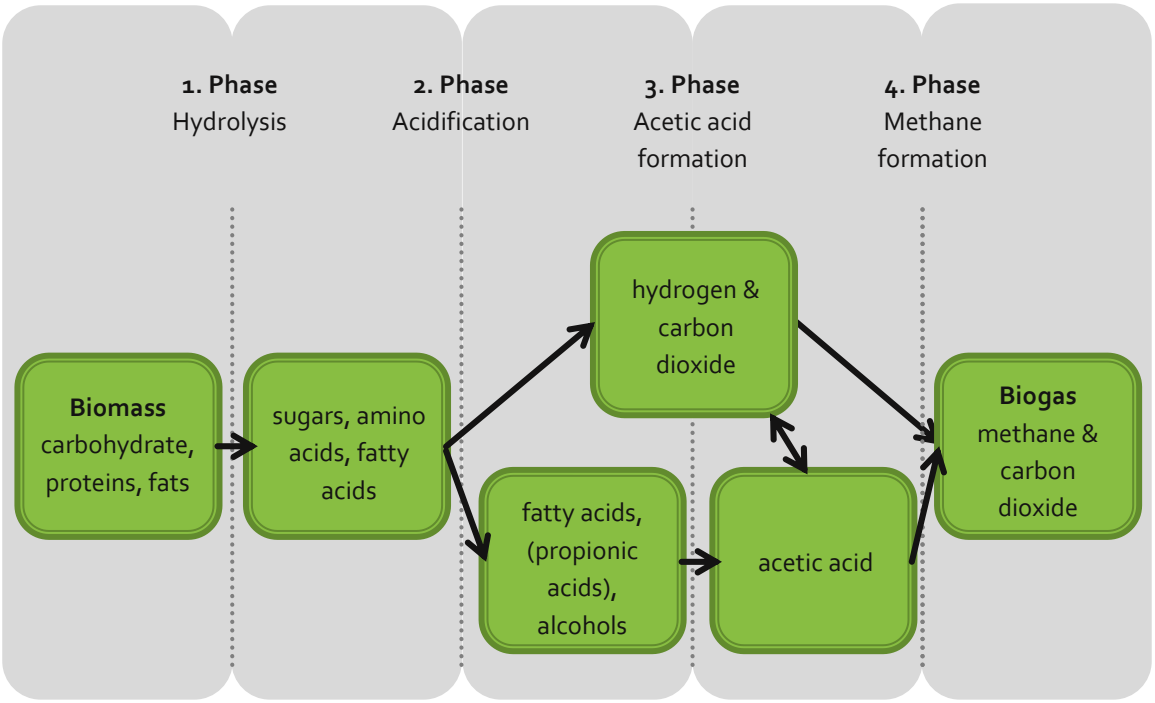

Figure 1: Schematic representation of anaerobic degradation phases [KTBL 2013, modified]

In the first step the "hydrolysis", the substrate, which is composed of complex compounds (like carbohydrates, proteins and fats), will be cleaved by exo-enzymes in more simple organic compounds (e.g. amino acids, sugars, fatty acids).

The intermediates formed are further broken down in the second step, the so-called "acidification" (acidogenese), through acid-forming bacteria to short-chain fatty acids (acetic, propionic and butyric acid) and carbon dioxide and hydrogen and small amounts of lactic acid and alcohols.

In the third phase, the so-called "acetic acid formation (acetogenesis), the products of acidification will be implemented mainly to acetic acid, hydrogen and carbon dioxide. The acetic acid is formed from organic acids. When this process step is disturbed, an enrichment of acids will occur, because only the methanogens can degrade the acetic acids.

In the last step of biogas generation, the so-called "methanogenesis", bacteria produce biogas over two pathways; from acetic acid and hydrogen and carbon dioxide [KTBL 2013].

Depending on the design and operation of the biogas plant as well as the used biomasses, different environmental conditions are required for optimal activity of the microbes. Therefore following parameters, among others, should be kept in mind [FNR 2013]:

- the oxygen input into the fermenter should not be too high
- the temperature in the digester should be matched to the involved microorganisms
  (e.g. at mesophilic operation: 37-42 C)
- the pH-value of the substrate in the fermenter should range between pH 6.5 and 8
  (at single-phase processes) and
- the digester should be balanced in terms of macro and micro nutrients.

In general, the operating conditions of a biogas plant should be kept as constant as possible. Especially important is the feed-in of substrate. Some typical mistakes concerning the plant feeding are:

- feeding substrate continuously over a long period of time
- substrate is to irregularly supplied
- fast switching of substrates with different composition/quality or
- feeding to much substrate after a "feeding pause" (e.g. due to technical problems).

The rate of gas production and the process itself is very sensible and can easily be inhibited. Inhibitors may decrease already in small amounts the degradation rate and gas production or lead to a complete standstill at toxic levels. For example, antibiotics can enter the digester via the manure. Even in small amounts antibiotics, disinfectants or solvents, herbicides or salts of heavy metals can inhibit the degradation process in the digester [KTBL 2013].

1.2 Biogas production

In agricultural livestock farms cost free substrates like manure, fodder residues and wastes incur. Manure only has a low energy density, because of the high water content and the rather low specific gas yield. This makes it less transport-worthy and economically unattractive at long transportation distances. In order to exploit the potential, inexpensive and easy to operate plants in low (power) capacity range are now available.

Slurry is hydraulically easy to handle. With a high proportion of manure in the digester, also hydraulically challenging substrates, such as grass or solid manure, can be used relatively easy in a small biogas plant [FNR 2013]. The adjustment of technology, used substrates and kind of operation thereby decides about the quality of plant operation and the achievable biogas yields. The substrates used ultimately determine the needed appropriate technology and their interpretation, such as cutting units, sizing of pipes, pumps, gas treatment, gas storage and CHP unit [LFU 2007].

Among the general technical requirements for a pure manure digestion, the heat balance can be a critical point – particularly during winter time. Especially at long periods of cold weather, the heat supply for the plant and external heat consumers, such as stables and residential buildings, might be difficult.

The market shows a considerable breadth of different technical solutions for small scale biogas plants, incl. wet fermentation and solid-state fermentation systems. The offered plant concepts range from custom-made systems which include existing facilities on farm (e.g. manure storage and pumps, buildings for the CHP installation or integration of new stable concept into plant construction) to various special concepts, where essential parts have been prefabricated by the manufacturer. Partial existing concepts have been specifically optimized for this type of plant with efforts also to simplify the cost [FNR 2013].

In summary it can be said, that depending on the type of substrate (e.g. fodder leftovers, litter or grass as a co-substrate) and local conditions (e.g. necessary construction for slurry storage), the technical suitability and benefits of each concept should be examined carefully and if possible with support of a neutral consultant.

1.3 Biogas utilization

The biogas produced is versatile. Mostly it is used in combined heat and power plant-units (CHP) on site. The electricity generated is fed into the public grid or used on site for self-consumption. The internal consumption of the biogas plant can be covered either by the power grid or from the CHP.

In addition to the electricity produced, a CHP also provides heat energy from exhaust and engine cooling. A portion of the generated CHP heat is used to heat up the digester. However, some heat generated is for any other use available [LfU 2007].

Biogas can also be used in boiler for generating low temperature heat for heating and drying equipment or for steam generation. The condition is that the biogas quality meets the requirements of the boiler.

1.3.1 Combined heat and power plant

As engines for combined heat and power units, spark-ignition or pilot injection gas engines are normally used. Spark-ignition engines (gas engine) are specially designed for gas operation and can be operated with methane content in the biogas from about 45 %. They have a gas mixer and a spark ignition ignites the gas mixture.

Pilot injection gas engine work on the diesel engine principle, which are accordingly series engines modified for biogas operation. They are often used for biogas plants with a lower power capacity, because the compressed gas mixture is mixed over injectors with small amounts of ignition oil (biodiesel, vegetable oil). And the engines can be operated with pure ignition oil, if the biogas has low methane content in the biogas or by failure of the biogas production [LFU 2007].

1.3.2 Biogas upgrading

Alternatively to electricity generation in a CHP directly on site, biogas can also be treated and upgraded into biomethane. Biomethane is a natural gas substitute produced from biogas, which can be injected into the natural gas grid and then be used like normal natural gas.

Physically, biomethane is the same as natural gas and therefor it can easily be used e.g. to generate electricity and heat in CHP or in turbines, boilers or as vehicle fuel.

With the upgrading of (raw) biogas and injecting biomethane into the natural gas grid, a spatial and temporal decoupling between biogas production and use can be realised. This allows a more efficient and demand-driven use of biogas. However, the connection to the natural gas grid is not always possible or economically feasible, as processing and grid connection costs require larger biogas plants [KTBL 2012].

The most common methods for upgrading biogas are pressure washing, pressure swing adsorption, the amine scrubbing and the treatment by membrane technology [KTBL 2012].

A decentralized electricity generation from biogas in plants with combined heat and power units is more attractive when a large part of the generated heat can be used in close proximity of production. In the pre-planning phase of a biogas plant all possibilities of biogas utilization should therefore be included.

1.4 Digestate treatment

The material terms of the digestate by spreading it on farmland in the immediate surroundings of the biogas plant is still the most (cost) effective variant to deal with the fermentation residues. The project development should clarify the question whether there is sufficient arable land for spreading available or if a guaranteed purchaser for the incurred digestate exists. Only when these options are not given, it makes sense deal with the processing of the digestate [FUCHS & DROSG 2010].

With processing and treatment of digestate, the pressure on the local rental market for arable land can be reduced, the transportability of the nutrients from the digestate can be increased, a potential excess of nutrients in the region can be defused and storage and application costs might be saved.

In addition, the marketability of liquid and spreadable fertilizers is increased and, not least, reduced environmental impact by avoiding volatile air and atmospheric pollutants.

The digestate treatment methods are divided into the following methods [KTBL 2013]:

- partial treatment: separation of solids and production of a nutrient reduced liquid phase or process water
- full treatment: removal of solids and production of an nutrient-rich concentrate; purification of the liquid phase up to a quality that permits a direct discharge into receiving waters.

The dimensioning and the strategy of a digestate treatment plant are primarily based on the following points [FUCHS & DROSG 2010]:

- Which digestate amounts inure during plant operation and what's the associated nutrient amount?
- Which share of digestate can be applied to self-owned or contractual (external)
- Are there other potential purchasers for the digestate in the region?
- What opportunities exist to promote the end products of digestate treatment such as for example compost or liquid nutrient?
- Is unused surplus heat from the operation of a CHP plant or similar available which can be used for the digestate treatment, like drying or evaporation?

1.4.1 Separation

The digestate processing begins with the separation of liquid and solid fraction in preparation for the subsequent, mostly mechanical or thermal processes.

The separation is performed mechanically using centrifuges or screw presses. For simple applications such as the separation for the production of thin liquid recirculated, no further processing steps of the digestate are required.

1.4.2 Treatment of the solid phase

With processing / treatment of the solid phase, a high-quality fertilizer can be produced. The removal of the water allows economically transport of the fraction over longer distances.

Drying process (like belt dryer, thrust reversing dryer, fluid bed dryer) remove the water in the digestate by overflowing it with a hot air stream. As heat source in this case, the surplus heat from CHP can be used. In addition to the removal of water, the digestate will be sanitized and pasteurized by using the CHP heat [KTBL 2013].

1.4.3 Treatment of the liquid phase

Beside the direct use of the liquid phase as liquid fertilizer it is possible, to continue the treatment process (full treatment) to achieve a quality of the liquid phase which allows the direct discharge into receiving waters. The effort, requirements and costs for this full treatment process are usually high.

A method to reach this treatment level is the membrane technology. Here, the liquid phase from the separation flows over a membrane which retains solid particles, bacteria, and, in the case of reverse osmosis, dissolved salts in water. The reverse osmosis has due to the large sensitivity of the membranes high demands on the input material: this must usually be first separated and filtered coarse and then pre-treated by ultrafiltration.

2. General information for realizing a biogas project

Biogas projects for energy production require a certain amount of investment and structural actions at the farm. That is why it is so important to plan such kind of project very well and specially to proof the economic sustainability of it before checking the technical feasibility. When realising a biogas project, project initiators (e.g. farmers) have the option of carrying out certain phasing of the project themselves, depending on their personal commitment and available financial and personnel resources.

Especially in the early phase of a project the project initiator or else the future plant operators play an important role. In designing a project outline for the first project assessment and for the subsequent development of a feasibility study the future plant operators can or must contribute own information, ideas, desires, expectations and decisions. This ensures that the framework is locally aligned and optimized thus to a long-term sustainable plan.

It is necessary to make project changes at the beginning of the project (as soon as possible) to have bigger positive influences in comparison to make them later in an advanced stage of the project (see Figure 2). Another advantage of doing this early is that costs and time are less than in advanced staged projects. For a successful and expected course of project this means, the sooner you act in an early project stage against wrong decisions, the more influence it has on the general costs of the project and it will cost less to do these changes. For this reasons it is extremely important to do an initial project evaluation even before a sustainability study.

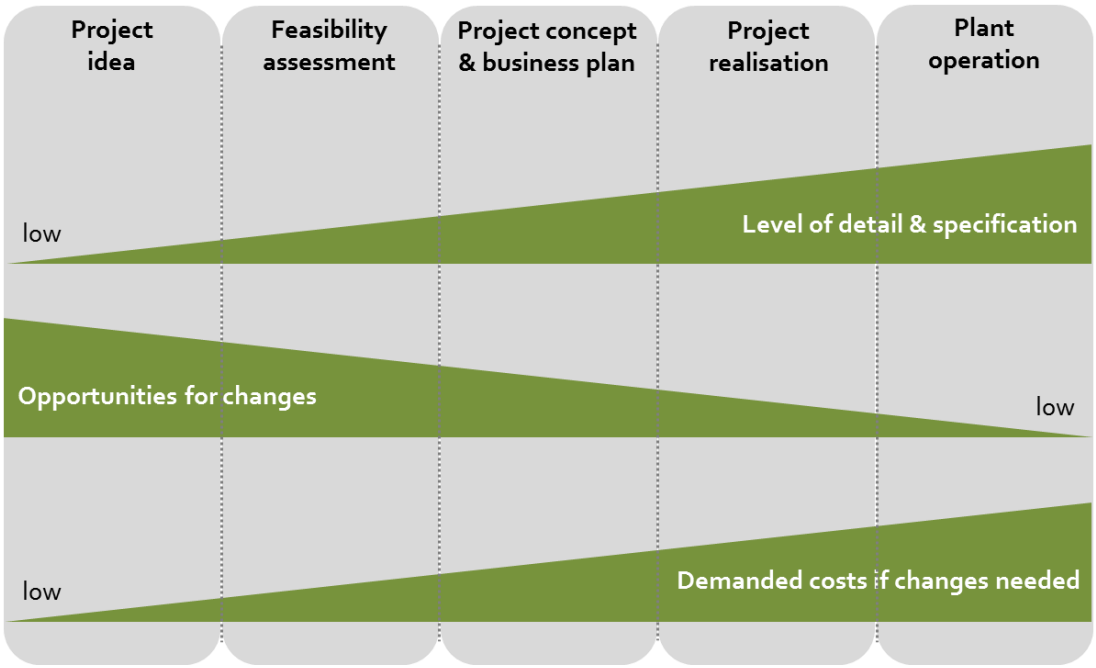

Figure 2: Level of detail, opportunities for changes and demanded cost for changes within the process of biogas project implementation

The preparation of project idea and feasibility study thus provides a discrete but evolutionary process of project development and realisation. Therefore the whole chain starting from biomass supply, to power generation and energy loss to digestate management has to be taken into account. And questions that arise along this chain have to be clarified [Eltrop et at 2014]. The individual phases of concept formulation, feasibility study, capital expenditure planning, permitting procedure, plant construction and commissioning are presented in this handbook.

The following Figure 3 shows the different essential steps or phases of the project development and some aspects which should be considered by implementing a biogas plant.

Figure 3: Essential project development phases and central questions for implementing a biogas plant [CASTILLO ET AL 2012, modified]

3.Project idea

The project idea begins with the questions e.g., if a biogas plant will fit into the agricultural business, will the project be helpful to enhance the farm in its development and what information's are needed to answer these questions and to develop a precise project idea.

This first step of the project embraces all the basic questions the farmer should have during his first reflection to decide, if he wants to go on planning a biogas project. As it is the first step of action, mainly general data collection, qualitative assessments and rough quantitative calculations can be done by the farmer itself.

When considering a biogas project, it is important to see the whole picture, including the availability of substrate, the actual biogas plant and the supply of energy to purchasers. The three aspects presented in Figure 2 must be considered from the outset in the same degree of detail, the objective being to carry out a well-founded initial evaluation of the project concept.

The farmer has to care about subjects like the availability of substrates for biogas use and the options for transport and storage, first settings on plant type and on categories of production capacity on the options for energy use so as information on plant location and implementation into the existing farm (see Figure 4).

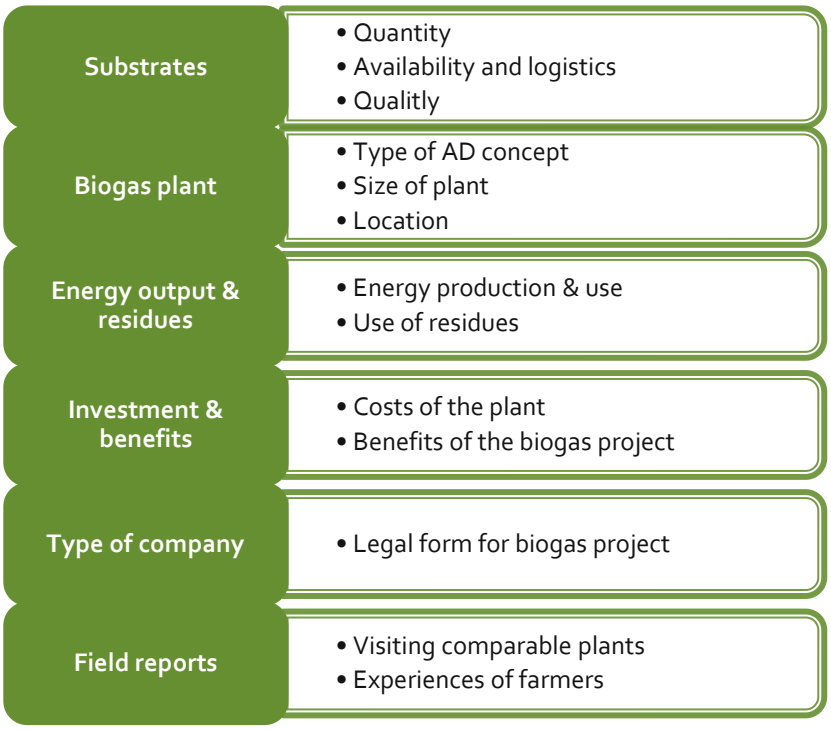

Figure 4: Subjects to be considered within the step "project idea" [CASTILLO ET AL 2012, modified]

An initial evaluation of the project does not require definite decisions on the above-mentioned aspects (this will take place in the subsequent planning phase). Rather, the aim is to ensure that there are at least one or, if possible, several options for successful realisation of the project [FNR 2013].

At the end of the first step "project idea", the farmer will have a clearer idea of his project thanks to first qualitative and rough quantitative calculations regarding the substrate provision, the plant capacity and the produced energy. The farmer will decide to stop the project or to go on and specify his project idea in more detail.

The following aspects for the first project overview will be described in more detail. The Annex 2 provides a checklist on the main aspects introduced below. The online calculation tool on www.bioenergyfarm.eu will be helpful by developing the project idea.

3.1 Feedstock availability

The farmer has to specify and pre-estimate the substrates available on his farm for running a biogas plant. This starts from the different kinds of feedstock / substrate available on the farm and also when the substrates will be available during the year (continuous, seasonal, once a year) in long term. But this only counts for fermentable substrates. Biomasses with high cellulose content or "bulky" substrates like horse dung with straw may need a pre-treatment before use. Woody biomasses are not suitable for anaerobic digestion. Additionally, the substrate provision from nearby farmers or industries should be considered.

The following questions are of relevance:

- Which kind of self-produced substrates (e.g. livestock manure or dung, clover-grass, energy crops and/or residues from agricultural production like potato peelings) are available in the long term?
- Do I have medium-term/long-term plans to change my farm?
- Will the farm-produced substrate be enough in long term for running a biogas plant?
- Will there be some suppliers nearby who can provide substrates regularly, in long term and to which costs?
- Is the use of these substrates worthwhile in view of the statutory requirements (question of proportionality, e.g. by using hygienic risky wastes)?
- Are the substrates suitable for the anaerobic digestion?
- Do I might need a pre-treatment for some biomasses?
- How much tonnes will be available ever year and when?
- Which pre-estimated qualities will the biomasses have (biogas yield per tonne)?
- How is the surrounding infrastructure - will the farmer and/or supplier will be able to transport the substrates easily and cheap to the plant?
- Etc.

3.2 Plant size and capacity

The substrate potential of the farm and the resulting biogas potential are decisive for the dimensioning and design of the biogas plant and producing energy quantity. Based on the pre-estimated substrate data the plants type, the category of the plant size and the plant capacity can firstly be estimated.

Plant technology for biogas recovery covers a very wide spectrum. There are virtually no limits in terms of component and equipment combinations. It must be noted, however, that expert analysis of plant and system suitability and capacity adaptation on a case-to-case basis are invariably required. There are several variant processes for generating biogas and many different concepts for small-scale anaerobic digestion on the market [KTBL 2013].

One question is what method or concept might be the right one for the substrate mix that will be gained from the farm. The classification of the processes for generating biogas according to different criteria [EDER 2012, KTBL 2013] like

- dry matter content of the substrate (wet digestion or solid-state fermentation)
- type of feed (plant runs continuously, quasi-continuously or intermittent (batch))
- type of concept (plant with stirred vessel, compact plant, tower systems / high fermenter)
- process temperature (mesophilic or thermophilic operation).

The plant size results significantly from the farm-produced substrate mix and its specific gas and methane yield, from which the producible biogas quantity can roughly be determined. Based on standard biogas yield values for each type of biomass used, the possible annual biogas-and methane yield can be estimated. This can be used for the dimensioning of the biogas plant and to estimate the producible energy amount. The capacity of the plant can be indicated in produced electricity (kWh_{el}), produced heat (kWh_{th}) or produced (raw)biogas or biomethane (m^3/h).

With the online calculation tool on www.bioenergyfarm.eu, the first assessment on biogas production and size of the biogas plant can be checked.

The information on the plant size will also contribute to think about the adequate and acceptable location for the biogas plant and to about the question how will operate the plant.

3.3 Energy output and residues

Based on the gas formation potential of the annual substrate for the plant, the expected amount of energy can be roughly estimated. The farmer should think about how he will use the produced energy. Depending on the conversion-process (CHP, boiler or biomethane production) different types of energy or products will be produced.

For biogas typically electricity and heat will be produced in a combined heat and power plant (CHP) on the farm. The electricity can be fed into the electricity grid or used to reduce the electrical purchase of the business. The produced heat is firstly needed to hold the process temperature of the plants. Depending on the plant size, the substrate mixture (high manure content has a high heating demand) and weather conditions, a varying amount of surplus can be used on the farm for heating and warm water production. It also might be possible to deliver external heat customers (e.g. greenhouses, pig farms, neighbouring houses and enterprises).

Biogas can also be used in a boiler for heat production only or, as an alternative option to CHP, be upgraded to biomethane (natural gas quality level) and fed into the national gas grid to be delivered to the customers directly.

In addition, the fermentation produces digestate as a by-product that can be used as fertilizer and therefore partially replace mineral fertilizer.

The properties of the digestate or their ingredients are essentially determined by the materials going into the fermentation process and the anaerobic digestion itself. The positive effects on the properties of the digestate are:

- reduction of odour by degradation of volatile organic compounds
- extensive degradation of short-chain organic acids and thus minimizing the risk for leaf burn,
- improving the (flow) properties and consequently reduction of leaf contamination of fodder crops and less effort during homogenization,
- improvement in short-term nitrogen effect by increasing the content of fast-acting nitrogen and
- destruction or inactivation of weed seeds and pathogens (human-, zoological and phytopathogenic).

Since the carbon fraction is changed by the fermentation of substrates, in essence the nutrients remain unchanged. The nutrients in the digestate are more soluble and therefore more available to plants after the anaerobic digestion process [KTBL 1999].

In addition, the digestate also carries a certain value, which can be calculated on the basis of current fertilizer prices. The value of 1 m³ manure digestate is (country specific) about 10 € per ton. Related to the value is also the transportability. At a distance of more than approx. 18 km the transport costs for digestate exceed the price for mineral fertilisers [EDER 2012] and transport is no longer feasible in economic terms.

The following main questions are of relevance:

- Which form(s) of energy do I want to produce (electricity/ heat, heat or gas)?
- Is the energy production only for farm-based (own) consumption?
- Who will buy the energy?
- Are there potential heat purchasers close to my farm?
- Do I have to invest in a local destitution network?
- How much heat needs to be supplied every month?
- Will there be enough surplus heat from a small-scale biogas plant, to ensure constant delivery to external heat customers?
- How much digestate will I produce?
- What opportunities of post-fermentation waste management are available?
- Will the post-fermentation waste management be an additional cost or income position?

3.4 Expected investment & benefits

Based on the rough estimation of the annual biogas yield from the available biomass and the resulting plant sizes, a first assessment of the necessary investment for the biogas plant can be done. In addition, first predications on the potential benefits and revenues can be made.

The online biogas calculations tool (visit www.bioenergyfarm.eu) gives the farmer the opportunity to get a general overview on the expected plant size resulting on the on farm situation and a first idea of possible costs and benefits of the biogas project.

3.5 Type of company for biogas businesses

The question of the legal form for the construction and operation of a biogas plant must be clarified early in advance of the project. The choice of the legal form is not just a question of tax burden, but there is a significant interaction between national corporation and fiscal law, cause the taxation law has normally different consequences depending on the legal form.

In many countries, individual enterprises are very common in agriculture. With the inclusion of an agricultural activity, either through the establishment of a company or from the transfer of a business, the owner becomes an individual enterprise who scores income for tax purposes. The advantages of a legal form for the establishment or acquisition of a biogas plant often depends on the size of the biogas plant and the way in raising capital. For small scale biogas plants it may be preferable in some countries, to operate them as a side business to the farm. Thus, the legal form of the farm

business is also critical for the companion business. The legal form can be individual enterprise or a business partnership, like a partnership organised under the civil code [FNR 2013, FNR 2013 B].

Biogas plants which will be run as a separate business, beside the initially farm business, might have a limited partnership or possibly a private limited company as legal forms. Differences between the individual legal forms are, for example, the liability, allocation of profits, publication requirements, capital raising and administration of a business [FNR 2013, FNR 2013 B].

The farmer should think in parallel about the nature/structure he'd like to give to his enterprise. An overview of the most relevant legal forms of company for biogas projects with characterization and description can be found in Annex 3 of the handbook (chapter 3.1).

In addition to the technical aspects of the biogas project, the fiscal aspect has to be kept in mind. This applies for example income tax, business tax or sales tax. Tax law related issues are not covered in this handbook, but they should be discussed in each case with a tax consultant or the taxation authorities.

3.6 Inspect existing plants (field reports)

For the development of a biogas project it is always beneficial to visit some existing plants as a way of acquiring experience and information. Therefore it is very helpful to get in contact with other farmers, biogas plant operator or plant builders to get information e.g. about

- experience of existing plant operators with various components and substrate combinations
- structural options available on the market
- practical information about realising a biogas project as well as about the bottlenecks
- structural/process-related problems and maybe how to solve them
- what kind of technical solutions where found
- experience in the planning and approval of the plant
- assessment of the needed project run-time from planning till energy production.

4. Feasibility assessment

Objective of the feasibility study is to analyse among other things the technical solutions and alternative concepts and to assess the level of risk. For this purpose, it is advisable to consult a specialist. The assessment leads to an overall impression and allows a specific recommendation for a specific concept, which can be further substantiated.

The implementation of a new operating branch in the existing agricultural business by a new biogas plant can substantially be attributed on the following arguments:

- to broaden the production base
- risk protection of the income by the use of the biogas power (new earnings)
- provision of liquid funds throughout the financial year
- energetic utilization of waste materials and by-products
- Reduction of emissions and odours from manure storage and application of fertilizers
- Improvement of plant availability of nutrients and enhancement of fertilizer application from manure
- autonomous energy supply and
- improved image.

Before the decision is made for biogas, the different possibilities of biogas production and utilization should be checked for the conditions set by the farm and possible risks should be assessed.

If the farmer wants to go further in his biogas project, he must define his project in a more precise way, analysing the different technical options and details for substrate provision, bioenergy production and utilisation. Additionally, he will study them to know if they are profitable in long-term and environmentally and socially acceptable.

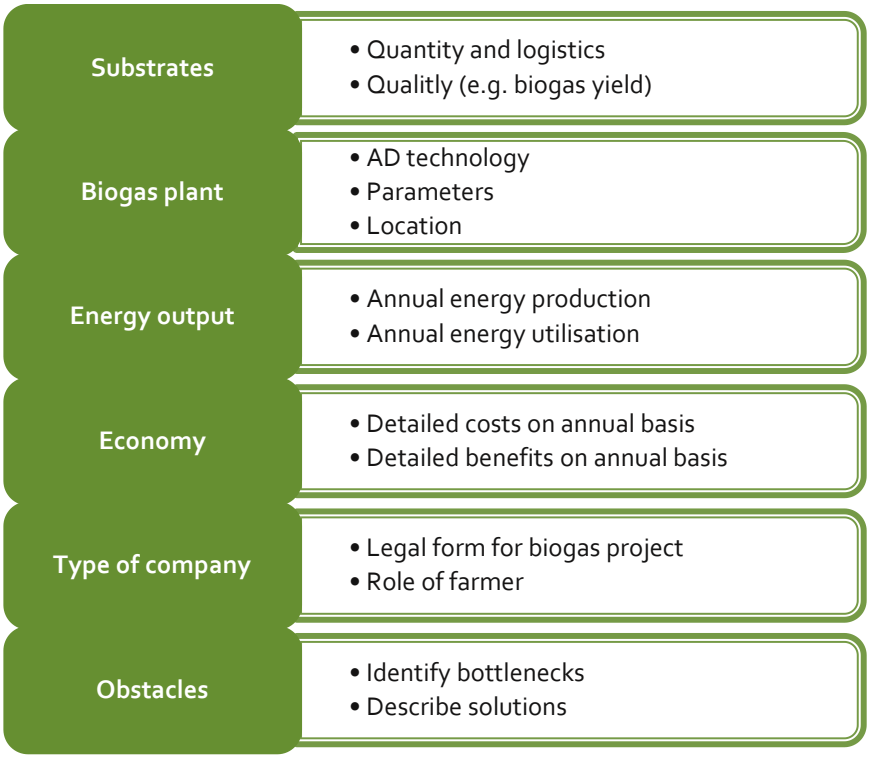

Figure 5: Subjects to be elaborated in detail within the feasibility assessment study [CASTILLO ET AL 2012, modified]

Chapter 0 shows that with growing level of project detail and establishment, the opportunities for technical and structural changes decrease. At the same time, the costs are increasing if changes are necessary. Thus, a well-structured and thorough planning is essential for (economically) successfully realizing a biogas plant.

For this purpose the farmer may ask a suitable association or a professional biogas consultant to give him support. They will ask the farmer for detailed information on the purpose of his project, his farm (agricultural production, livestock), the surrounding area, etc. They will provide the farmer with technical and practical information and will give him good advices to optimize his biogas project. They will make detailed calculations on the substrate potentials, plant size, energy output and utilization as well as of the demanded yearly costs and yearly income.

Together with an expert or consultant, the farmer can use the expert calculation tool (offline version available on www.bioenergyfarm.eu) to get further in his biogas project by creating a feasibility assessment.

Different project options have to be studied deeply during this step. Those options are all well-described and feasible (profitable and respectful of social/ecological aspects in the long-term). At this time the farmer should be very aware about everything which deals with realizing and running a anaerobic digestion plant – such as the fermentation biology, the substrates, the different types of companies he can create for the plant, how to make a detailed overview on costs and incomes, the required building conditions regarding environmental and social aspects, demands for the plant operation, etc.

4.1 Substrate potential

Starting points for the establishment of an agricultural biogas plant should be among others the available manure and residues on farm, the worthwhile local heat sink and exploitation potential for the digestate.

Specifically, it is this necessary to determine the available amount of manure and its properties (like dry matter and organic dry matter content), which are depending on the kind of livestock and the type of animal husbandry (a reference value is 0.15 till 0.2 kW/livestock unit (500 kg live weight)). To determine the amount of manure e.g. agricultural advisory services or technical literature can be used. It should be noted, a single slurry sample often provides only an uncertain value - this applies to the determination of the process flow as well as for the biogas yield determination in the laboratory.

In addition, the amount of agricultural residues (such as fodder leftover, Silo topcoats, etc.) and, if available, by-products have to be detected as possible cost-neutral substrates (in temporal and quantitative amount in observance of availability and transport distances).

The dimension of the project (plant) is mainly determined from the biogas-production rate of the substrate mix. The standard biogas yield values for each type of biomass used (see Table 1) allows to predict the annual biogas-and methane yield and therefore the energetic capacity of the plant (which is baseline for the economic feasibility of the project).

The achievable biogas yield is influenced by the composition and storage of the substrate and by the process technology itself. The storage time of liquid manure before the digestion process for example affects noticeably the biogas potential. Thus, the biogas yield can be reduced after one week of storage by up to about 50%.

The estimation of the expected yield of gas, which is necessary for the construction of biogas plants as part of the planning, will be based on individual experience. This leads to very different dimensions of the equipment under otherwise identical initial conditions. Since biogas plants are characterized by high capital requirements and longevity, errors appearing in the system design are often serious, because later correction of design defects is usually not possible. For these reasons, (uniform) standard values for estimating the gas yield of agricultural biogas plants are used on the basis of existing knowledge [KTBL 2015].

Table 1: Standard biogas yield values for some substrates of agricultural biogas plants (biogas yield in standard volume) – an abridgment [KTBL 2015]

Substrate	Characteristics	Dry matter content (DM)	Organic dry matter content (oDM)	Biogas yield	Methane share
		% of fresh matter	% of dry matter	l_n/kg oDM	%
Poultry dung	depending on the straw-feces ratio, little stored	40	75	500	55
Cattle dung		25	85	450	55
Cattle manure	incl. fodder residues	8,5	80	380	55
Pig manure	-	6	80	420	60
Maize silage	-	35	95	650	52
Grain silage	medium grain fraction	35	95	620	53
Fodder beet silage	oDM acidily corrected	16	90	700	52
Clover grass silage	-	30	90	580	55
Grain litter	-	88	85	650	56

The farmer, e. g. together with an expert or consultant, has to quantify and specify the substrates available for the biogas production on the farm. Additionally, substrates available on neighbouring farms will be considered in the quantification if willingness on participation has been announced by other parties. Information is necessary on which substrates are available regularly and which substrates are available seasonally, on transport distances and means as well as on storage facilities.

The online calculation tool on www.bioenergyfarm.eu will be helpful by the determination of the annual biogas and energy production of the biogas plant.

4.2 Biogas technology

The technical details of the biogas plant need to be specified (e.g. plant concept, size/capacity, compounds, material of the digester, type of gas utilisation (CHP-Unit, boiler, biomethane production etc.) and eventually options for heat utilization.

In this context, different technical options/solutions for substrate provision and bioenergy production and utilization have to be elaborated. Additionally, an appropriate location for the biogas plant (including storage, additional rooms or installations, etc.) has to be identified (see chapter 4.3).

Moreover, in addition to choose the right plant concept some conditions should be noted, such as:

- existing storage capacity (for silage, digestate)

- heat requirement of the operation or the surrounding customers (volumes, annual load profile)
- entry points for electricity
- integration into the heat supply net
- if necessary, a redundant source of heat (in case of failure of the CHP during winter)
- usable buildings substance (e.g. for CHP or gas storage) or storage vessel as a new digestate storage
- workload of the plants suitable for labour available on-farm
- arable land for application of digestate

4.3 Suitable location

With increasing plant size and technology, the importance of the right plant location increases. The possibilities for distribution and use of the produced energy are particular important here.

It has to be kept in mind that the transport of heat is only economically sensible over a short distance and the transmission of electricity in the low voltage range might also result in a reduction of the economic yield because of significant line losses.

For the site search it is relevant, how the distribution of the substrate and the digestate will be realized. Furthermore, it must be determined whether the necessary substrate quantities and qualities on site are available in the longer term.

These are some influences on the choice of the site location for a biogas plant [FNR 2013, modified]

- legal requirements (distance regulations (emissions, noise, hygiene), water protection)
- infrastructure (roads, logistics)
- minimal pumping distances, minimal driving distances for front loader, use of gravitation instead of pumping
- distribution of energy products (entry points of electricity (transformer), heat sink location, micro gas line, entry point to gas grid (biomethane) or location filling station)
- distribution areas of the fermentation products (digestate)
- geological settings (water protection area, construction ground)
- expansion capabilities of the plant
- funding (funding opportunities related to the location).
- etc.

4.4 Energy output and use

The farmer together with the expert or consultant will calculate the yearly amount of electricity, heat or gas resulting from the different solutions identified above.

The energy demand of the anaerobic digestion plant as well as the one from the farm incl. associated building and other (external) customers will be identified.

4.5 Economy

Starting points for the establishment of an agricultural biogas plant should be the available manure and residues, the useful utilization of the produced heat and the exploitation potential for the digestate. The decisive aspect in the decision to build a biogas plant is the question of whether the inserted factors capital and labour can be adequately remunerated. In other words, can the proposed biogas plant be operated economically?

For the so far identified farm-based (plant) concepts, the total investment costs have to be identified as well as the probable cost of operation including all variable and overhead costs for the whole biogas plant and additional relevant buildings and installations. With the BioEnergy Farm II calculation programme (offline tool available at www.bioenergyfarm.eu) the farmer can, with support of the expert, determine the economic situations of the concepts. The tool comprises information on demanded total investment costs, the upcoming annual costs (also for operation, maintenance capital allowance, replacement investment, personnel, insurance etc.) and yearly income from selling the produced energy. So the farmer will get an overview of the costs and income of the biogas plant on a yearly basis. Additionally, he can match the data with his personal and operative financial situation which is essential for the decision making process. With the help of a balance sheet, an overview on life time basis of the plant and information on the payback period of the project will be given.

The combination of biogas production and animal husbandry are clear synergies in terms of economy and often also in terms of work-based economy. It is important that the size of the biogas plant and thus the labour requirement is adapted to the operating conditions of the farm.

In this phase, the farmer must ask himself the questions, e.g.:

- how can I manage the investment (commitment periods up to e.g. 20 years)?
- how much time will be required every day for routine inspection/maintenance work?
- is this workload compatible with the situation on my farm (do I need extra staff)?
- what working time model is possible for my family (e.g. who will take over the farm after me)?
- etc.

Although the economic analysis of the feasibility study on an economically promising result comes, it is necessary to continue to question the economics of the project critical. If a lack of profitability emerges, nevertheless the possibility of terminating the project should be taken into consideration.

4.6 Type of company & role of the farmer

The expert will help the farmer (and possible partners) to evaluate the pros and cons of the different types of companies and to decide for the best options. Additionally, the farmer and the expert will evaluate the impact of the different biogas solutions on the farmer's current activities.

It is important that the size of the biogas plant and thus the labour requirement is adapted to the operating conditions of the farm. The required work load for the biogas plant operation can mainly assign to following process steps:

- biomass management
- plant operation incl. substrate preparation and feeding
- process monitoring, maintenance and troubleshooting
- administrative tasks and
- digestate application.

All parts of the process are necessary for operation, but they can be linked to very different labour requirements depending on the mode of operation and substrate. The work schedule must be included in the considerations to avoid surprises at the stage of pre-planning in any case [FNR 2013].

Before starting to operate an anaerobic digestion plant, it is advisable that operators and staff will have a certain qualification to run a plant, so that they have basic knowledge about the biological process (helpful for trouble shooting). The qualifying measure raises also the awareness of the operator for potential hazards on site and helps to safely operate the plant (professional cooperatives and some insurance companies require this for the system operation).

4.7 Project bottlenecks

For successfully realizing a biogas project bottlenecks have to be identified in an early projects stage and solutions have to be discussed.

In this context, it is helpful to meet the local authorities in an early project stage to check if it is realistic to build a biogas plant in the chosen area etc.

Moreover, it is necessary to evaluate the risks of each possible biogas concept, i.e. the effects of lower plant availability, higher yearly costs, lower income, spare parts availability, emission and noise sources, occurring problems with the neighbourhood, logistics, grid connection etc.

5.Project concept and business plan

Based on the conceptual work which was done in the previous steps, different solutions for the on farm biogas project could be identified and the feasibility assessment has also examine the economic, environmental and social aspects. With this preliminary work and the feedback of the supporting expert, the farmer has to choose the most feasible concept for his situation in the long term and write a business plan.

The farmer has to decide which biogas solution is the most promising one - and which concept will be realized. This project developing step is the most important and difficult to do, as it contains the final decision on the biogas plant project concept detailing each aspect of the selected project.

The business plan will allow the farmer to present his on-farm biogas project efficiently, especially to authorities and banks.

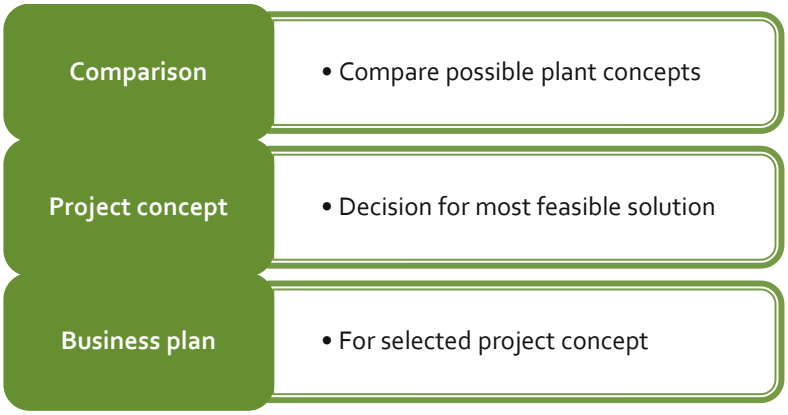

Figure 6: Subjects within the step "project concept and business plan" [CASTILLO ET AL 2012, modified]

5.1 SWOT-Analysis

The farmer and the expert will make comparisons between the different concepts and plant solutions by evaluating the pros and cons of each of them. They are related to technical aspects, environmental, economic and social conditions, the role of the farmer and expected bottlenecks.

The comparison can be carried out with the help of a SWOT analysis. It is an important part of the business plan. The strengths and weaknesses analysis is used for systematic observation of products, processes, enterprises and other objects to be analysed. The analysis can easily and relatively quickly identify existing problems and show opportunities of the project.

The farmer will answer the following questions which can be summed up in a short table for each biogas solution/concept:

"**S**trengths": What strengths are characteristic for the project?

"**W**eaknesses": Are there any weaknesses which have to be taken into account?

"**O**pportunities": Which special opportunities are offered by project realization?

"**T**hreats" of a project: Are there any threats, especially from the economic, legal or technical point of view?

An exemplary overview of a SWOT-Analysis for a biogas plant project can be seen in Table 2. In the first step of the SWOT analysis, the four areas are to be filled with content.

The internal influences are factors, which can be influenced by the farmer or person / institution that belongs to the project. Opportunities and threats, however, describe the business environment. Thus could be, for example, new markets or increasing heating costs. Threats may be, for example, political developments or declining demand.

The external influences are factors, that can`t be influenced by the farmer or person / institution that belongs to the project. The strengths can e.g. be market positions or successful / useful products. The weaknesses can be, e.g. inefficient processes or upcoming dependencies. The gathering and analysis of own strengths and weaknesses return the internal point of view.

The analysis start ideally with the aspects strength and weakness - this involves an objective consideration of the project. Subsequently trends of the respective strengths and weaknesses are created which determine whether the particular trend can be used as an opportunity or pose a risk for the project. With the strengths / weaknesses profile and the resulting opportunities and risks, an essential element of the business plan is developed.

Table 2: Exemplary overview of a SWOT-Analysis for a biogas plant project

SWOT	Positive	Negative
	Strength	Weakness
Internal influence	▪ new source of income ▪ new markets (for digestate) ▪ increasing heating costs by customers ▪ substitute mineral fertilizer ▪ low payback time ▪ self supply ▪ …	▪ inefficient process ▪ upcoming dependencies (substrate supply) ▪ lack of labour ▪ biomass purchase ▪ …
	Opportunities	Threat
External influence	▪ inefficient operation ▪ lack of knowledge ▪ finding new markets ▪ …	▪ increasing biomass costs ▪ political developments ▪ declining demand ▪ high inflation ▪ …

5.2 Business plan

The farmer, supported by the expert, has to make a decision on the biogas project concept he wants to realize on his farm. The decision will be based on the SWOT analysis results but also on e.g. financial or personal preferences.

The elaboration of the business plan will be the following step of the concept development. The business plan is prepared and formulated to summarise the project idea and the new agricultural branch operation. The business plan describes in detail how this would work for the project, to whom it is directed, where the opportunities and risks lie and whether the project is worth it.

It serves not only the future plant operators but is an important decision document for banks, authorities and possibly for business partners. The business plan will sum up all the details of the selected project concept. It refers to all the details elaborated within "the feasibility assessment study".

The business plan comprises about 15-18 pages and should contain:

- Purpose of the investment (general reason to invest, reasons to invest for farmer)
- description of non-technical aspects (e.g. form and legal status of company, location, market analysis, subsidies, social and ecological aspects)
- overview on technical aspects and dimensioning of the biogas plant (technical description of the plant, demand on amount, transport and storage of substrates, demand on manpower for operation etc.)
- economic viability incl. tables with economic data (investment plan; annually cost plan, plan on yearly revenues and plan on profitability, etc.)
- SWOT analysis
- additional explanations by the bioenergy farm expert.

In a well-written business plan, the critical points of the project are discussed and checked. As a result, the project stands before the realization on solid ground which prevents risks by planning deficiencies. Further, the business plan has several important functions, such as:

- during preparation of the business plan, the farmer shall be critical to the project in order to check its feasibility (can the plant be implemented?) and its cost-effectiveness (will it be profitable?)
- it is also an informative document for banks or lenders, potential funding bodies and / or investors. Funding bodies will demand for such a business plan, but also for business partners it is an important document and guideline during the implementation of the project and for operating the new branch of the farm.

6. Project realization

This project development step comprises all activities from getting permits for building and operation, organising the financing and funding for the bioenergy project till the fundamental planning of the plant construction and bringing it into service. The farmer has to get into contact with different authorities and institutions, as e.g. consultancy firms for detailed planning, banks, local communities or companies which will be needed for building the biogas plant. Additionally, the farmer has to provide all the data and plans relevant for successful project realization.

The complexity and time frame of this step among others is depending on type and size of the biogas plant and especially in which country the plant will be erected. Also the proceedings and effort for e.g. getting permits may also differ for each country and also within the various provinces.

Apart from the technical parts, aspects of acceptance are also very important for realizing a bioenergy project. It must be considered to involve the public in an early stage to avoid unpleasant delays later in the project realization.

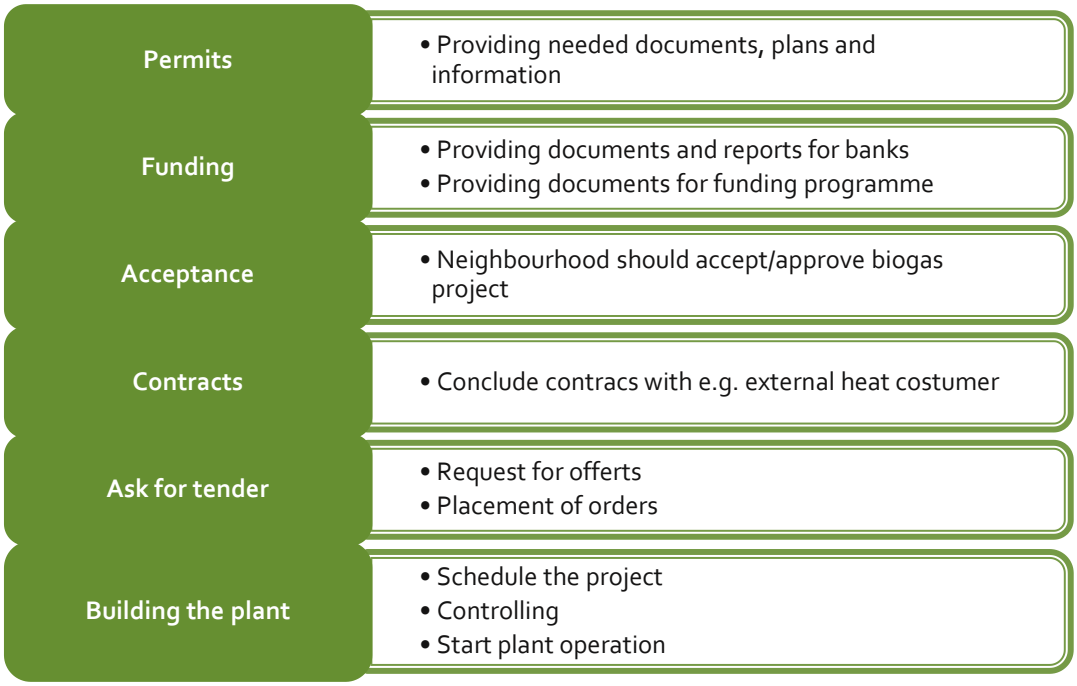

Figure 7: Tasks within the step "project realization" [CASTILLO ET AL 2012, modified]

6.1 Permits

Agricultural biogas plants are often built close to agricultural sites (farms) and are often, depending on national legal framework, seen as a "building structure" and therefore needs at least a building permission by national construction law.

Some plants need approval according to Emission Control Regulations, also depending on national legal framework. These approval processes are normally more complex as well as more demanding and requires higher efforts in terms of time, organization and finances than the permission by construction law.

In principle (in many countries), there is a right to a plant authorization, if public regulations and concerns of occupational health and safety are not indicating otherwise. The regulations relating to the construction and operation include, for example [EDER 2012]:

- construction planning act
- occupational health and safety law
- water protection legislation
- nature conservation law
- waste legislation
- fertilizer act
- hygiene legislation.

The farmer has to get the required permits for building and operating the biogas plant from the local authorities and maybe other relevant institutions. It may be necessary to realize a detailed technical plan of the plant location and construction to receive those permits.

Some requirements to be considered by the manufacturer and/or farmer for construction of a biogas plant:

- noise and odour report for operation near residential areas, if necessary
- sufficient storage capacity for digestate (no land-spreading during winter time)
- landscape conservation plans
- fire protection design
- structural engineering (statics) for tank construction
- observe the requirements for concrete quality
- technical and operational safety acceptance of the facilities for starting operation
- etc.

The applicant should contact the responsible approval authorities early in the process. The first discussion, in which the designer of the plant should be present, is to introduce the project to the authority. It is not only to make personal contact with the authorised person, but it will illustrate the framework of the project clarifies what conditions are imposed and what documents are required.

For producing and injecting of biomethane (biogas upgraded to natural gas quality) into the gas grid, special regulations have to be observed.

The approval of planning should be done in close contact with the plant manufacturer or delegated plant planner themselves and the agricultural advisor. Depending on the type of the required permit and the approval authority the amount of documents that have to be handed in may vary strongly [FNR 2013]. A Checklist for the compilation of the approval documents can be found in Annex 2.

Chapter 3.2 of Annex 3 gives an overview on the proceedings for permit for biogas plants. The chapter 3.3 in Annex 3 gives also an overview on the emission regulations for biogas plants.

6.2 Project financing and funding

Bioenergy projects are generally financed through own funds and / or borrowings or loans. Under certain circumstances, the project can be financially supported through funding from promotion programs (public funds).

An essential prerequisite for a project financing is basically the appraisal in a feasibility study (see chapter 0). The content and results of the feasibility study can, among other things, convince potential lenders and investors from the technical feasibility, economic viability and creditworthiness of the project.

Basically a credit institution and / or a qualified financial advisor should be involved early in the preparation of a financial plan to get the feedback on affordability in an early stage of the project (e.g. at the end of the feasibility study). The requirements of the bank concerning project information, documentation and collateral should also be clarified in time, which then form the basis for the comprehensive appraisal. The funding can be tightly coupled to the operator model and the legal form of the company (chapter 1.1).

The provision of equity capital is usually essential for lending by banks. Normally, a minimum ratio of equity capital in form of a self-financing or a quasi-equity loan has to be provided to receive state financial assistance or standard bank loans. The equity capital includes also cash assets and contributions in kind (e.g. operationally necessary goods). The capital requirement depends on the ownership structure (existing or newly established companies), the specific investment costs and the economics of the project [ELTROP ET AL 2014].

In the case of partial financing through a credit, the early contact with a credit institution is important for a successful financing. The bank is the first and crucial point in this way. It offers free consultations to be informed about various financing and funding opportunities, ranging requests for financial assistance to the relevant institutions. For borrowing the provision of adequate guarantees is absolutely necessary. The presence of sufficient collateral is thus a crucial part of project financing. The protection of the loans by the bank might be guaranteed e.g. by:

- mortgages (charge on the land)
- collateral assignments (e.g. the entire plant or individual machinery)
- guarantees or
- purchase guarantees for produced power and heat.

Form and scope of standard collateral should be agreed as part of the loan negotiations between the borrower and the bank [ELTROP ET AL 2014].

The framework of project funding differs from country to country and is also regional in its nature, scope and objectives. Basically, the promotion can be distinguished in subsidies in investment and development loans (interest-subsidized loans). A comprehensive overview and information on county specific current programs and grants can be found in the Annex 3.

6.3 Improving acceptance

The biogas technology has so many positive aspects. It is a e.g. a renewable energy source, has versatile utilisation forms (electricity, heat and fuel), can be used flexible (bioenergy which is storable and allows energy production on demand) and generates additional income for agriculture and rural areas. Despite all this, in some countries the biogas technology is treated negatively in the media and biogas investors have to deal increasingly with citizens' groups and neighbours who are against the biogas plant (NIMBY-Effect - not in my backyard).

Social barriers or poor acceptance are often related to the increasing traffic for transporting and harvesting energy crops (too many vehicles, too noisy and too many exhaust emissions). In addition, there is often the opinion in public that biogas plants are smelly and also dangerous (danger of explosions) so that the plants are not tolerated near residential areas. Also, in some regions the cultivation of energy crop is seen problematically. Opponents claim that intensive energy crop cultivation has negative effects on the beauty of the landscape, decreases biodiversity and causes over-fertilisation of soils plus excessive use of pesticides and herbicides.

Therefore the farmer should get into contact with his neighbours to present them the biogas project and discuss it together (visiting existing biogas plants would be an idea). Experience proves that it is always better to involve the public in an early stage to make them understand the benefits of the project, so they don't feel disregarded and complain at the end.

Apart from the technical planning a number of aspects of acceptance are relevant, which must be considered in advance of the plant building, if necessary. This is in the first place the early information of the public or neighbours. Essential criteria of a good acceptance are e.g. [EHRENSTEIN ET AL 2012]:

- creating an open communication atmosphere and the responsiveness for insecure neighbours,
- name potential impact of the biogas plant, such e.g. odour development, increasing transport traffic, in a realistic way – don't whitewash the issues (e.g. it "never stinks")
- involve (local) proponents of the project in the public relations
- clarify the question of plant location early and if possible amicably
- appoint benefits of the project for the community
- offer opportunities for participation
- where appropriate involve mediators for conflict prevention and resolution
- residents should be given the possibility to get to know the biogas plant, for example by arranging an "open day" presentation
- a good and responsible plant management is indispensable and requires expertise.

Events for interested citizens for presenting information and allow discussions about the project are an essential part of the planning procedure. External experts may be invited to discuss certain issues (e.g. legal framework, health, etc.) and thus to increase the level of information and understanding to the local people [EHRENSTEIN ET AL 2012].

6.4 Contracts

For realising and operating a biogas plant it may be necessary to clarify certain trade relations in bilateral treaties. The number and legal nature vary depending on the business model.

Essential for every project is usually a plant construction contract. Also the substrate supply and digestate delivery must often be contractually regulated. In addition, a plant management contract can also be completed, if necessary. By selling surplus heat of the own CHP or (raw)biogas to external customers, delivery contracts may be required. Also concession agreements with private landowners and easement agreements with the municipality might be of importance for the plant operator.

All contracts should be tailored to the individual needs of the contractors to offset their own best interests. The contracts with energy customers (e.g. for heat delivery) have to be updated regularly.

In chapter Annex 1 (General information on contracts) different types of contract are presented and essential aspects are described in detail.

6.5 Tendering procedure

The farmer should do a tendering process to choose the best plant manufacturers for building the biogas plant. Therefore the future plant operators must inquire the manufacturer, which will be considered to build the plant, to create and submit offers which are comparable and allow a thorough evaluation. For a good comparison some offers should be sought.

When comparing the offers it is important to look beyond the mere price. Equally important is the quality and expected/guaranteed output offered, the experience of the manufacturer and the services they propose when it comes to support, repair or maintenance of the biogas plant. It is also from importance to decide, whether it should be a turnkey construction by plant manufacturer (low work load and project planning time required) or if it should be plant and realized by an engineering company (larger share of own work on construction possible).

As mentioned before (see 3.6) it's always beneficial to visit existing plants of the manufacturers or engineering company and get in contact with the plant operators in order to benefit from their experiences.

6.6 Building the plant and start of operation

A good project management needs a good organization. Therefore it is important that the farmer has a good overview on the plant building phase. Unexpected events and costs must be avoided to ensure that the project will be finished successfully.

The farmer has to make a detailed schedule with the plant builder / manufacturer to have an overview on the whole process of plant building and installation. It enables the various parties to deal with bottlenecks and avoid interruptions at an early stage. Each step must be presented in terms of resource requirements, budget and duration and they must follow a logical order. Regular reports on construction process help to keep this schedule updated.

During the construction, farmer and expert have to check scrupulously three points:

- Quality: Is the job under control and professionally executed? Does the farmer really receive what he expected/ordered? Do plant parts have failures? The security of a biogas plant is a very important aspect.
- Financial aspects: are there any unexpected expenditures? If yes, why weren't they anticipated?
- Deadline: is the building operation on time regarding the time-schedule (sometimes, start of operation has an effect on amount of feeding-in tariffs)?

After building and installation of the biogas plant has been finished, the facility starts operation. For that, it will be tested and approved (failures will be reported) by the plant manufacturer and/or authorised experts. After successful testing and commissioning the biogas plant is ready to produce biogas.

7. Plant operation

The project realization ends when the anaerobic digestion plant has been built. The next and essential step of the project starts when all structural and technical components of the plant are installed and the operating license has been granted: the start of operation.

7.1 Start of operation

For the staring-up various tests and inspections must be organized and carried out. Initial operation of a biogas plant is made up of the technical (duration a few days) and the biological part (duration some weeks).

Before starting up the biogas plant, the plant owner must check if all the obligations included in the building permission are fulfilled. The entire gas system should been tested for tightness. The documentation for the technical units as well as for the entire biogas plant must be present, which also includes instructions for initial operation, a risk assessment and an explosion protection document [EDER 2012].

Starting up a biogas plant should always be done by the company who designed and built the plant. During the start-up phase, the farmer and the staff who will operate the plant, will be advised in running and maintaining the biogas plant.

From a technical perspective the start-up of the biogas plant is only acceptable, if the safety devices are functioning and in compliance with the regulations information about safety listed in the operating instructions of the manufacturer [EDER 2012].

Biological initial operation is often referred to as "start-up", depending on the used biomass the process needs minimum some few weeks' time and can last up to 6 months. The biological start of a biogas plant should be thoroughly planned and organized in advance and already possible before the technical start-up [FZ 2013].

Table 3 shows and describes the different steps for starting the biological operation.

Table 3: Organization the start-up of a biogas plant [KTBL 2013]

Start-up phase		Specifications and sources of error
1	Creating a stat-up schedule in cooperation with an expert	Starting the process of the anaerobic digester is from the biological, economic and safety point of view a critical phase. The frame conditions (substrate input, biological activity and DM content of the inoculum) of each start-up are different
2	Fill 50-60% of the digester with manure or fermentation product, possibly diluted with water	Level should be high enough so that all inflow and outflow openings are sealed and no air can enter the digester / gas storage (explosion protection). Alternatively, all inflow and outflow openings need to be closed (also applies to gas pipes)
3	Slow heating up of the digester to operating temperature (max. 1°C/d)	The microorganisms must be able to adapt to the rising temperatures
4	Inoculation of the fermenter with fresh digestate; amount approximately 20% of the reactor contents mentioned under step 2	Fermentation starts with increasing gas production and CH_4 content. The gas is discharged via the overpressure protection. Aspects of explosion protection must be observed. The biogas can be used in the CHP, as soon as the gas has reached a CH_4 level of >45%

Start-up phase		Specifications and sources of error
5	For CH_4 contents > 50%: initial charge with fresh substrate and gradually increasing the load (weekly about 0.3-0.4 kg oDM / (m^3 · d))	Rapid increase in load increases the risk of instability in the biogas process. Too slow increase leads to economic losses through delayed achievement of full load operation.
6	Process analysis at least once weekly needed	Allows a customized increase of the load by occurring instabilities.
7	Comparison of targeted and actual analysis results (substrate input, acid level, gas or electricity production) with the start-up schedule	Adjustment of the substrate feed-in to meet the intended power output, so that an economical operation is possible.

7.2 During operation

When the biogas plant has started its operation, which daily, monthly or yearly measures are necessary for control, maintenance and for securing substrate and fuel provision? From now on the farmer has to do regular controls and maintenance to assure security, safety (especially concerning emission standards) and efficiency.

For a farm scale biogas plant, with an electrical power capacity (equivalent) of up to 75 kW_{el}, the labour time (net) for operating and maintenance is usually approx. 1.8 hours per day [KTBL 2013].

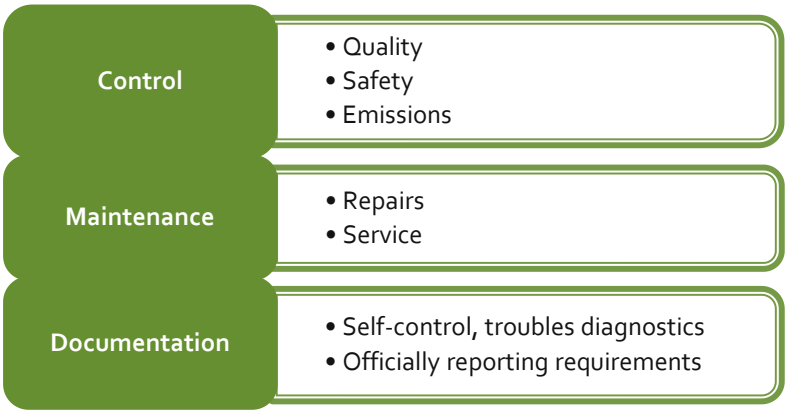

Figure 8: Aspects for plant operation [CASTILLO ET AL 2012, modified]

7.2.1 Process Control

The required measures/tests (either on a day to day basis or in case of problems) should have been listed and detailed in the plant instructions of the manufacturer who built and installed the facility.

An analysis of practice data from operations diaries of 31 German biogas plants showed that within a year a total number of 1,168 operational disturbances were documented by the operators [KTBL 2009]. It was found that the plant component CHP-Unit, solid substrate feeder, pumps and agitators were the most susceptible parts. The qualitative evaluation of this disturbances showed, that the biological process has been the fifth most frequent reason (see Figure 9) of malfunctions.

For this example, 4,282 working hours were necessary to solve all the malfunctions. This corresponds to an average of 138 working hours per biogas plant and year. On average for every 10 kW of installed electrical power 1.2 malfunctions occurred per biogas plant and year.

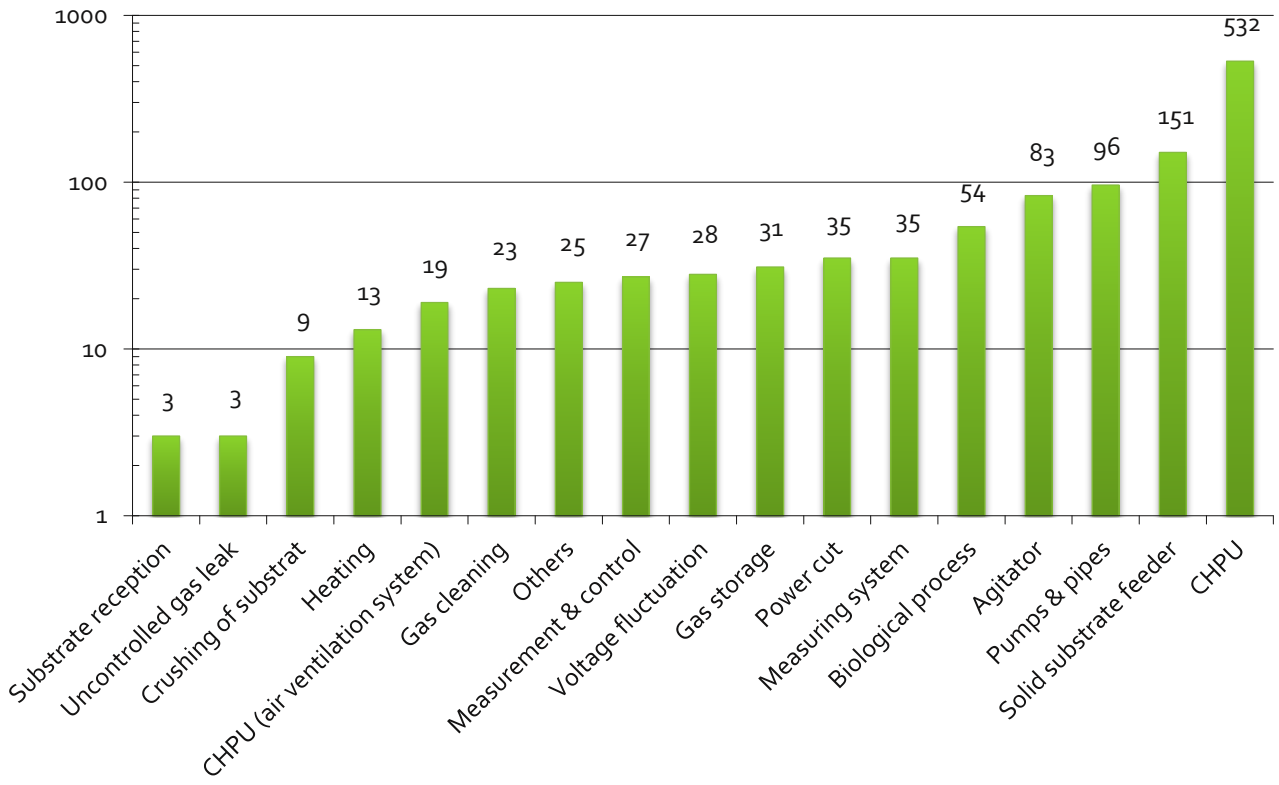

Figure 9: Most frequently incidents documented on 31 German biogas plants over one year period [KTBL 2009]

These results point out the importance of consequent process control. Most significant indication for a process disturbance is a noticeable decrease of biogas yield respectively methane concentration. In contrast to technical problems – which can regularly be solved quite fast – process disturbance are more difficult to correct and require a basic understanding of the farmer for the biological processes and inhibition of the anaerobic fermentation.

7.2.2 Maintenance

Most of the controls may be done continuously by control and monitoring systems (like temperature of the reaction, the amount of substrates, the quantity of gas/electricity/heat produced, etc.) but others might require expert support or can be done by the farmer himself (e.g. resolve liquid leakage at pumps, oil changing at CHP, small repairs etc.).

The farmer has to ensure maintenance and observe the maintenance intervals (important for warranty of plant parts) of the biogas plant and the downstream equipment. Some maintenance can be done by the famers himself (e.g. scheduled replacement of wear parts as filters, seals and replacing or replenishing supplies or consumables like engine oil or water) or by certain service providers (e.g. general overhaul of CHP unit).

Measuring is the precondition for process control and optimisation. But the necessary measurement equipment creates costs, which often – especially on small scale installations – tried to be avoided during implementation.

7.2.3 Documentation

Consequent documentation is the only way to get reliable information on status and efficiency of the biogas production process. The collection of data over a longer period is not only necessary for self-control, but also relevant in case of troubles diagnostics and consultancy by external experts.

As a very simple, effective and less laborious method is the so called „input or operations diary". Furthermore in some countries (for example Germany) data on input of the plant must be available due to legal requirements.

Advantages of an input diary are [GOMEZ 2008]:

- traceability of quantity and quality of input substrates (also supplier where needed)
- control and optimisation of volume load
- economic efficiency calculations (supplier, gas demand, electricity demand, operation hours)
- process control
- gas leakage detection

The input diary should include the following information:

- amount of every substrate or substance given into the process
- process temperature
- gas quality (CH_4, CO_2, H_2S)
- gas yield
- amount of gas utilized
- power production (net)
- operating hours
- fuel demand (in case of pilot injection gas engine)
- electricity injected to the grid
- services, disturbances
- etc.

7.3 Safety of biogas plants

Construction and operation of a biogas plant is related to a number of important safety issues, potential risks and hazards for humans, animals and the environment. Taking proper precautions and safety aim at avoiding any risks and hazardous situations, and contribute to ensuring a safe operation of the plant.

Fulfilment of important safety issues and stipulating clear preventive and damage control measures is a condition for obtaining the building permit (this may differ depending on country):

- fire & explosion prevention
- mechanical dangers
- sound statically construction
- electrical safety
- lightning protection
- thermal safety
- noise emissions protection
- asphyxiation, poisoning prevention
- hygienic and veterinary safety
- avoidance of air polluting emissions
- prevention of ground and surface water leakages
- avoidance of pollutants release during waste disposal
- flooding safety
- collision and tear-off protection.

Apart from poisoning and asphyxiation, there are other potential dangers related to the activity on a biogas production site. In order to avoid these types of accidents, clear warnings must be placed on the respective parts of the plant and the operating personnel must be trained [SEADI ET AL 2008]:

- Other potential sources of accidents include danger of falling from ladders or uncovered areas (e.g. feed-funnels, maintenance shafts) or to be injured by movable parts of the plant (e.g. agitators).
- Equipment like agitators, pumps, feeding equipment is operated with high electrical voltage. Improper operation or defects of the CHP unit can result in fatal electric shocks.
- Risks of skin burning through unprotected contact with the heating or cooling systems of the biogas plant (e.g. motor coolers, digester heating, and heat pumps) must be considered. This also applies to parts of the CHP unit and to the gas flare.

For these reasons, it is advisable that operators and staff of a biogas plant are trained on plant safety. This qualifying measure raises the awareness of the operator for potential hazards on site, it helps to safely operate the plant and to establish safe procedures if external companies need to work on the biogas plant.

Annex 1. General information on contracts

1.1. Plant construction contract

The plant building contract regulates the structural condition and is the centrepiece for the construction of the biogas plant. The main regulation points are significantly depending on the concept and the size of the plant. From the perspective of the plant operator, in particular the following points are in need of regulation [FNR 2013]:

- whether the project is realised by an engineering company or as turnkey construction, the contract should possibly including all trades/crafts, agreement of specific performance and should contain detailed service specifications
- coordinated technical requirements of the plant are observed (e.g. minimum hydraulic retention time)
- bank guarantees or other valuable collateral can reduce the cost risk in construction as well in the warranty period
- a specific completion date should be agreed, also rules in terms of delays to compensate for revenue losses (penalty)
- clear rules for the test operation (scope, duration, power values, retries, etc.) and acceptance should be made
- agreements to "whether and how" of subsequent changes of the scope of work (reduction and / or extension) increase the flexibility, even if a request of change was not clear included in the contract
- a reduction of the statutory warranty circumference should be avoided. The aim of the plant operator is instead the longest possible warranty period
- a forward-looking planning covers a contractual right to supply spare parts to fixed or at least determinable prices (price adjustment clauses) for as long as possible
- usually, the payment will be agreed on progress of construction work. The amount of progress payments based on the economic value of the trades/craft or partial performance, the maturity date results from the project schedule / construction schedule. The payment of the last rate should not take place before the end of the express warranty, but in any case not before lodgement appropriate securities (warranty bond).

1.2. Management and maintenance contract

The biogas plant must be regularly serviced and maintained. Plant operators normally negotiate maintenance contracts for their biogas plant, occasionally supplemented by management contracts. If the plant manufacturer or constructors don't offer maintenance services, the operator should demand written maintenance requirements. Intervals and amount of maintenance should be defined as detailed as possible in written form [FNR 2013].

The following points should be taken:

- in addition to the plant construction contract a maintenance contract with the plants manufacturer or builder is recommend (negotiated at the same time)

- the term of the maintenance contract should not be less than the warranty period from the plant construction contract
- to obtain warranty claims, a maintenance contract is useful for the plant operators who has not the technical skills for maintenance.

1.3. Substrate delivery and digestate collection contracts

In addition to the initial investment, the operating costs of the plant (e.g. for substrates and their delivery) determine in particular on the cost efficiency of the plant. Costs and arrangements for substrate supply are at an early stage to be considered in the calculation of profitability with an appropriate risk surcharge.

In substrate supply contracts, delivery volumes of renewable resources (energy crops) are usually defined on area basis, because the harvest is not fixed from the outset. In good harvest years, it may therefore come to an over-supply of substrates in poor to a shortage.

The exploitation of the digestate can also be negotiated in a contract after completion of the fermentation process and the corresponding storage of the digestate volume. In practice, it has been proven many times that the substrate supplier takes back the digestate to use it as fertilizer on his agricultural land [FNR 2013].

In substrate supply and digestate collection contracts can be found - in addition to the usual rules on liability etc. - regulations on the following points [FNR 2013]:

- term of the contract, including rules on termination and contract renewal
- delivery quantities or information on cultivated area stating the expected yields and any minimum quantities delivered, including where appropriate options
- price adjustment mechanisms, usually based on an index or several indices (e.g. consumer price index, diesel fuel index or substrate price index), depending on the term of the contract
- harvesting business service and delivery logistics, i.e. agreements on whether the operator or the substrate supplier harvest, the chopping, the removal, silage plus compression of the substrates takes over where they are stored and how long they have to be stored / may as well
- digestate collection (volume, responsibilities, dates, periods, deadlines, prices) including logistics (in particular transport, storage, distribution) under consideration of the requirements for the application of digestate as fertilizer.

1.4. Heat supply contract

Upon conclusion of a heat supply contract similar points have to be considered as for a biogas supply contract, such as arrangements to the quantities delivered, run time or remuneration. In addition, further regulation is needed for the following points.

Depending on the type of heat utilization (cooling buildings, feeding into a heat network, process heat, etc.) different requirements are to be observed and the fulfilment of which has to be ensured in the heat supply contract. It is important from the perspective of the CHP plant operator, to agree on a total purchase obligation or minimum purchase obligation of the heat customer [FNR 2013].

1.5. Biogas supply contract

The produced biogas is normally converted into electricity in one or more of CHP-units on site or its surroundings (satellite CHP) owned by the plant operator. However, this is not mandatory. The plant owner may also sell all or part of the raw biogas produced. The buyer then provides the utilization, such as electricity and heat production in his own CHP, heat production in a boiler or the upgrading into natural gas quality (biomethane) in a separate biogas upgrading plant.

A supply contract for raw-biogas is not subject of particularly energy law requirements. Mostly the raw biogas is transported in own piping systems or networks.

The contract for delivery should consider the technical, economical and legal interests of both parties reasonably. Usually, a biogas supply contract contains the following regulations [FNR 2013]:

- a sectional regulation of the supply volume by minimum or maximum quantities (number of kilowatt hours of biogas per hour / day, etc.). Such delivery quantities corridor takes the natural fluctuations in biogas production into account, without neglecting the interests of both parties on reasonable predictability
- the contractual (minimum) term and clearly defined mechanisms for termination and renewal of the contract are of importance for both parties. The longer the contract term is, the more important the price adjustment clauses are
- price adjustment clauses can be tied onto neutral indexes like e.g. electricity prices or prices for substrate on the stock market or consumer price index, etc.. Price adjustment clauses should reflect the respective cost risks in the first place, specifically in relation to the fixed duration of the contract agreed. The agreement should explicitly regulate, whether and how changes affect the purchase price for the raw biogas
- depending on the intended use of the raw biogas by the buyer, the definition of certain desired properties of the raw biogas is recommended. According to the functionality and technical requirements of the power generation unit, the buyer will set certain quality needs for the raw biogas (minimum methane content, etc.). The gas quality is also important for those buyers who upgrade the raw biogas into biomethane. In this case, the criteria shall also be in accordance with the technical requirements of the biogas upgrading plant
- At which point the ownership of the raw biogas shall pass on to the buyer, is also needed for reasons of risk assumption. For this purpose, the local conditions and ownership are noted for example at the piping system or the gas storage(s)
- The contractual obligation to supply includes the transfer of ownership of a certain amount of raw biogas in a certain quality. It is therefore necessary to make arrangements for the measurement of the quantity and the quality of the raw biogas and to regulate the corresponding bearing of the costs.

1.6. Concession agreement with land owners

The construction and operation of a biogas plant on the property of the plant owner represents the rule. However, if e.g. an operated satellite-CHP – in own operation or by a third party –, or the produced raw biogas fully or partly supplied by pipelines or the generated heat transported via heat pipes, the consent of adjacent property owners may be required. For this purpose, concession agreements concerning law of obligations are concluded. The duration of such a concession agreement should correspond to the expected need.

The compensation schemes should, due to the long term nature of such a project, contain price adjustment mechanisms. The protection of the rights of use of land owned by others should necessarily be done by appropriate easements entry in the land register. This will ensure that the rights are not lost in the case of sale of land or in the event of the insolvency of the other party [FNR 2013].

1.7. Path easement agreement with the community

If pipelines for a district heating network or (raw)biogas network laid along public roads, it may be required that the operator of the biogas plant and the operator of the heating network enters into an easement agreement with the responsible road authority. This one-time or annual access fees are agreed in most cases [FNR 2013].

Annex 2. Checklists

2.1. Checklist for developing a "project idea"

Table 4: Checklist for the first step "project idea" [CASTILLO ET AL 2012, modified]

Phase	Steps	Checked	Comments
1. Evaluationof the agricultural potential			
	Your fields and farm: Clearly identify the available substrates and estimate the quantity in tons per month/year for each of them		
	Animal waste (manure, dung, slurry, etc.)		
	Agricultural residues (like fodder leftover, grain litter etc.)		
	Household waste (like food/kitchen wastes)		
	Other		
	In the neighbourhood: Who could be interested in providing their manure, by-products or residues? Identify the available substrates and estimate the quantity in tons per month/year for each of them		
	Other farmers		
	Schools or company kitchen (food/kitchen waste)		
	Agro-industrial company (organic industrial waste)		

Phase	Steps	Checked	Comments
	Others		
	How much will it cost		
	First (preliminary) calculations of the farm's biomass potential and the annual costs for the plan		
	Use the online calculation tools of BioEnergy Farm II (www.bioenergyfarm.eu) for a first assessment of the economic feasibility of your planned project		
	Check the results which will describe the different costs (investment, substrate cost, logistic costs, operational costs, etc.) and the net incomes.		
	Get in contact with a national biogas experts for consultancy and advice.		
2. Evaluation of transportation			
	How is the quality of the surrounding infrastructure?		
	Can trucks freely use those roads?		
	Which substrates have to be transported anyway (tons/year)?		
	How much will the logistics be (€/year) and is it worthy for it (normally less than ca. 18 km ensures profitability)?		
3. Project purpose			
	Determine the energy consumption of farm and private housing.		

Phase	Steps	Checked	Comments
	Determine the nature (gas, heat, electricity) and the quantity of energy which is required.		
	Are there selling opportunities (e.g. surplus heat, Biomethane as transportation fuel) nearby?		
	Inform yourself about the prices and the conditions (period, gas quality, quantity of energy that can be sold, etc.).		
	Determine with the clients their needs (quantity and nature of the produced energy). Check that it's about a long-term bond.		
	Think about how the energy will be transported (heat net, filling station etc.).		
4. Nature/Structure of the company			
	Inform yourself about the most common forms of company and their specificities.		
	Identify the persons who may take part in your project. Discuss with them about their involvement and their responsibilities.		

2.2. Checklist for approval documents

Table 5: Possible documents for the approval of a biogas plant [FNR 2013, modified]

Building application forms / application forms on emission control regulatory approval	Request the forms at the responsible authorities for the approval process
Qualified location map/drawing	This has to be acquired at the municipal cadastral and land surveying office
Land Registry abstract	Information about the ownership, commercial type and location of the site
Plant and Operations description	Forms with plant data, type of processes (incl. material utilization overview) as well as plant and operation description created by the designer
Emission / immission	Presentation / description of the emission-causing processes / operations of the plant
Noise certificates, odour surveys and/or emission source plan	If the licensing authority decides due to special conditions of the location that a report must be created, a certified expert (authority on the subject) has to be assigned.
Waste management / utilisation	If necessary (based on the used substrates), presentation of the application and disposal methods of the used waste and used plant parts.
Plant Safety	Description of the plant under fire safety point of view, depicting a fire protection plan by the planner, possibly creating a fire safety report produced by an approved expert. Description of measures to ensure safety requirements, location plan with possibly explosion zones on site.
Intervention in nature and landscape	Compatibility of the project on the basis of existing planning conditions (e.g. land use plan, development plan). Representation of compensation or reparation measures for intervention relevant projects components.
Authorization under EU-regulation for animal by-products	Request for approval of the biogas plant according to EU-regulation for animal by-products (EC No. 1069/2009) e.g. by the use of manure or dung.
Site plan with distance space	Create accordance with the requirements of the safety regulations for agricultural biogas plants of the agricultural professional associations
Structural calculations for major components of the biogas plant	The statics of the large components are created and supplied by the plant or component manufacturer

Installation plan	This is created by the designer/planner
Detail drawings	This is created by the designer/planner: piping plans (for substrate, gas, heating media) incl. slope, flow direction, dimensions and material properties consideration of the explosion zones areas (ex-zone plan) type and design of reloading points for manure, silage and other pourable substrates engine building / room with the necessary installations heating pipe plan incl. connection with the heat producers and consumers basic flow diagram with operating units current flow diagram for the integration of CHP in the operation gas storage, gas-safety valve unit substrate storage
Flow diagrams for process plants	Creating a basic flow diagram with operating units by the planner.
Digestate utilization	Presentation / documentation of the necessary areas for agricultural application of digestate
Asset retirement obligation Statement	Undertaking by the applicant on decommissioning and dismantling of the plant and soil sealing after permanent termination of the permitted use.

Annex 3. Country specific data and information

3.1. Types of legal forms of companies

3.1.1. Belgium

Table 6: Characterization of the most relevant legal forms of company for biogas projects in Belgium [FOD 2014, IMPULSE 2014, EUNOMIA 2014, NOTARIS 2014]

	Sole trader (één-mans-zaak)	**One person private limited liability company** (besloten éénper-soonsvennoot- schap met beperkte aansprakelijk-heid/EBVBA)	**Private limited liability company** (Besloten vennootschap met beperkte aansprakelijkhei d/BVBA)	**General partnerschip** (Vennoot-schap onder firma/VOF)	**Cooperative company with limited liability** (Coöperatieve vennootschap met beperkte aanspakelijkheid/C VBA)	**Cooperative company with unlimited liability** (Coöperatieve vennootschap met onbeperkte aansprakelijkheid/ CVOA)	**Public limited company** (Naamloze vennootschap/NV)
Shareholder	One natural person	One natural person	At least two natural or legal persons.	At least two natural or legal persons.	At least three natural or legal persons.	At least three natural or legal persons.	At least two natural or legal persons.
Capital deposit	None	18,550 € (12,400 € deposit)	18,550 € (6,200 € deposit)	Amount as stipulated by the articles of association.	18,550 € (6,200 € deposit)	Amount as stipulated by the articles of association.	61,500 €

	Sole trader (één-mans-zaak)	**One person private limited liability company** (besloten éénper-soonsvennoot- schap met beperkte aansprakelijk-heid/EBVBA)	**Private limited liability company** (Besloten vennootschap met beperkte aansprakelijkhei d/BVBA)	**General partnerschip** (Vennoot-schap onder firma/VOF)	**Cooperative company with limited liability** (Coöperatieve vennootschap met beperkte aanspakelijkheid/C VBA)	**Cooperative company with unlimited liability** (Coöperatieve vennootschap met onbeperkte aansprakelijkheid/ CVOA)	**Public limited company** (Naamloze vennootschap/NV)
Liability	Owner is 100% liable (business and personal)	The person has a maximum liability as large as his or her participation in the EBVBA	Each shareholder has a maximum liability as large as their participation in the BVBA	Each partner is unlimited joint and several liable	Each partner has a maximum liability as large as his or her participation	Each partner is unlimited joint and several liable.	Each partner has a maximum liability as large as his or her participation
Legal capacity	No legal form	Legal form	Legal form	Legal form	Legal form	Legal form	Legal form
Management/ representation	Owner	Manager(s) a selected by the shareholders	Manager(s) a selected by the shareholders	Presumption of mutual proxy between the partners	Manager(s) as selected by the shareholders or board of directors.	Manager(s) as selected by the shareholders or board of directors.	Board of directors elected every six years
Taxation	Income tax	Corporation tax on turnover	Corporation tax on turnover	Profits of a VOF are taxed with the partners for their share in the profits	Corporation tax on turnover.	Corporation tax on turnover	Corporation tax on turnover. Advance levy on income derived from securities

	Sole trader (één-mans-zaak)	**One person private limited liability company** (besloten éénper-soonsvennoot- schap met beperkte aansprakelijk-heid/EBVBA)	**Private limited liability company** (Besloten vennootschap met beperkte aansprakelijkhei d/BVBA)	**General partnerschip** (Vennoot-schap onder firma/VOF)	**Cooperative company with limited liability** (Coöperatieve vennootschap met beperkte aanspakelijkheid/C VBA)	**Cooperative company with unlimited liability** (Coöperatieve vennootschap met onbeperkte aansprakelijkheid/ CVOA)	**Public limited company** (Naamloze vennootschap/NV)
Assessment/ important criteria	▪ No minimum capital ▪ Offers tax advantages when the income is low ▪ High reputation because of personal liability ▪ No division between the business profit and the owners income sometimes resulting in overall higher tax.	▪ Minimum capital required ▪ Separation of the own income with the business.	▪ Minimum capital required ▪ Special regulation for starters ▪ No personal liability ▪ Separation of the own income with the business.	▪ Solidarity between the partners ▪ Risk of liability for other partners	▪ Minimum capital required ▪ The amount of capital attributed by the partners may vary in size. ▪ Separation of the own income with the business.	▪ No minimum capital required ▪ No personal liability ▪ Offers tax advantages when the income is high ▪ Separation of the own income with the business.	▪ Minimum capital required ▪ Separation of the own income with the business.

3.1.2. Denmark

Table 7: Types of companies relevant for micro scale biogas plants in Denmark [JUF 2014]

	Owner managed company	**Partnership with personal liability of partners**	**Private limited company**
Shareholder	1	2+	1+
Capital deposit	0	0	10.700 €
Liability	personal	personal	10.700
Legal capacity	No legal form	Legal form	Legal form
Management/ representation	Owner	Elected among owners	Elected among owners
Taxation	Personal or corporation tax	Corporation tax	Corporation tax
Assessment/ important criteria	none	none	Capital deposit

3.1.3. France

Table 8: Characterization of the most relevant legal forms of company for biogas projects in France [ADEME 2012, SAFER 2014]

	Jointly run farms or collective farming grouping: GAEC **Civil society (non-trading company)**	**Farm with limited liability: EARL** **Civil society (Non-trading company)**	**Limited Partnership: SCEA** **Civil society (Non-trading company)**	**Limited Liability Company: SARL** **(Commercial company)**	**Simplified Stock Corporation: SAS** **(Commercial company)**	**Individual farmer**
Shareholder	Min. 2 /Max 10	Min. 1 /Max 10 pers.	Min. 1 /Max 10 pers.	Min 2 /Max 100	Min 1/ Max several	One natural person
Capital deposit (Corporate capital)	Min. 1,500 € Fixed or variable.	Min. 7,500 € Fixed or variable. The partners have to make contributions (no required capital)	No minimum. Fixed or variable Contributions in cash, in kind: lands, farm implements, cattle…	No minimum	No minimum. Contributions in cash, in kind: lands, farm implements, cattle…	None
Liability	Limited liability to the double of the capital input	Liability limited to their capital input: their private capital is therefore protected.	Collective liability of the partners on their private properties, proportionally to their capital input	Liability limited to the capital input of its members	limited to the capital input of its members	Owner is 100% liable (business and personal)
Legal capacity	Legal form	Legal form	Legal form	Legal form	Legal form	Legal form

	Jointly run farms or collective farming grouping: GAEC **Civil society (non-trading company)**	**Farm with limited liability: EARL** **Civil society (Non-trading company)**	**Limited Partnership: SCEA** **Civil society (Non-trading company)**	**Limited Liability Company: SARL** **(Commercial company)**	**Simplified Stock Corporation: SAS** **(Commercial company)**	**Individual farmer**
Management/ representation	Manager must be a partner farmer. All partners must participate equally in the work and management of the grouping	Manager must be a partner farmer	Manager partner or not, nominated by the partners articles of association	Fairly simple Manager has to be a physical person, not inevitably a partner	The Chairman, who may be either a physical person or a legal entity, is the only legal compulsory manager	Owner
Taxation	No corporate tax on turnover.	No corporate tax on turnover	No corporate tax on turnover	Corporate tax on turnover	Corporate tax on turnover	Income tax under the category of agricultural profits

	Jointly run farms or collective farming grouping: GAEC **Civil society (non-trading company)**	**Farm with limited liability: EARL** **Civil society (Non-trading company)**	**Limited Partnership: SCEA** **Civil society (Non-trading company)**	**Limited Liability Company: SARL** **(Commercial company)**	**Simplified Stock Corporation: SAS** **(Commercial company)**	**Individual farmer**
Assessment/ important criteria	▪ Advantageous tax regime: consideration of the number of partners for the thresholds of fixed profit and the capital gains taxation ▪ The members of the grouping keep their individual farming right ▪ Compulsory administrative agreement	▪ The advantages inherent to installation as an EARL can be counter-balanced by an increase in tax ▪ Companies cannot be associated by an EARL	▪ Company simple to constitute. No limitation concerning surfaces to be exploited. Can be associated by the physical, moral persons (companies, societies), that they are farmers or not ▪ Associated, the farmer loses his boss status of exploitation ▪ The salaries of the partners and the fringe benefits are taxed as the agricultural profits, conforming to income tax ▪ With the exception of the major repairs, charges are not deductible from profits	▪ Heaviness of functioning ▪ Transfers of parts are free between partners	▪ Expenses and formalism of constitution ▪ Very rigorous writing statutes ▪ Liberties of the partners to determine the functioning rules and transfer of shares ▪ Evolutionary structure facilitating partnerships	▪ The formalities of start-up are reduced at least ▪ Before a notary, possibility of declaring not professional properties, imperceptible

3.1.4. Germany

Table 9: Characterization of the most relevant legal forms of company for biogas projects in Germany [FNR 2013, FNR 2013 B]

	Individual Enterprise (Sole Proprietor)	**Joint Ownership (Partnership organised under the civil code)**	**Limited Partnership**	**Private Limited Company**
Manager / Shareholder	One natural person.	At least two natural and/ or legal persons (shareholder)	At least two natural and/ or legal persons.	One or more natural or legal persons.
Capital deposit	A minimum capital is not required.	A minimum capital is not required.	A minimum capital is not required. Each partner is, according to his capital contribution, involved in the capital of the company (shareholding).	The share capital must be at least 25,000 €. At entrepreneurs companies, the minimum share capital must be 1 € (with existing statutory reserves).
Liability	The sole proprietor is liable without limitation with his entire private and corporate assets.	The shareholders are liable, without limitation, with their respective total private and corporate assets.	At least one partner has unlimited liability with its assets (general partner). The limited partner is only liable for their deposits.	The private limited company is liable with all its assets. The liability is limited to the capital stock, i.e. the partners are liable only for their contributions.
Legal capacity	The sole proprietor may acquire rights and incur liabilities. He can acquire property and other rights in rem in immovable property and sue and be sued.	Available.	Available.	A legal person.

	Individual Enterprise (Sole Proprietor)	Joint Ownership (Partnership organised under the civil code)	Limited Partnership	Private Limited Company
Management/ representation	The sole proprietor conducts the business under his name or his companies name at his own expense and risk. He can run the business through an employee or authorize a third party to manage the business.	All shareholders are entitled and obliged to management The partners decide about the kind (single or joint representation).	Only the personally liable partner is entitled and obliged for the management. By contractual agreement, the Board may be transferred to one or more limited partners.	Represented by one or more managing directors. Shareholders have no right of representation. Manager may be an outsider or a partner.
Taxation	The sole proprietor is subject to trade tax if, by the results from a commercially-run biogas plant, revenues are generated. The owner of the company is subject to income tax, but not the company. The sole proprietor is obliged to VAT.	Income tax is payable by the shareholder with their profit share. Sales tax and trade tax apply largely the same as those applicable to individual entrepreneurs.	The shareholders themselves are subject to income tax. The limited partnership is generally subject to turnover tax and trade tax. No corporate income-tax liability.	A private limited company is subject to corporation tax on their income. It is considered as a trading company and is therefore subject to trade tax. The company need to retained capital gains tax, if it distributes profits to its shareholders. A private limited company may possibly by subject to sales tax law.

	Individual Enterprise (Sole Proprietor)	Joint Ownership (Partnership organised under the civil code)	Limited Partnership	Private Limited Company
Assessment/ important criteria	An obligation for accounting for individual agricultural entrepreneurs arises, if the self-managed agricultural and forestry area amount an economic value of more than 25,000 €, the income from agriculture and forestry is more than 50,000 €year or the turnovers are more than 500,000 € per calendar year. If the given limits are not exceeded, a simplified revenue surplus statement is sufficient. Smaller businesses may possibly report their profits according to average rates. Biogas plants, which are managed as companion businesses of a major agricultural business, shall be considered as special uses.	Suitable for commercial transactions with one partner. No minimum capital constrained. Risk liability (members of society sticking with social and private capital). High reputation due to the personal liability. With regard to the accounting and financial reporting obligations, the same conditions apply as far as possible as for an individual enterprise.	For entrepreneurs looking for further start-up capital, but want to remain in own responsibility. The general partner runs the business alone. Limited partner has a financial interest in the company.	A limited liability company is created only with entry in the commercial register. Simplest form of trade society. Entrepreneurs want to limit liability. Provides tax benefits when income is high. Comparatively high cost of establishing and accounting. Company adheres to the entire corporate capital. Liability of the members is limited to their own contribution.

3.1.5. Italy

Table 10: Characterization of the most relevant legal forms of company for biogas projects in Italy

	Sole trader	**Company**						
	Sole trader	**Partnership**		**Corporation**			**Limited Partnership**	**Cooperative**
	Sole trader (Imprenditore individuale)	**General partnership (non-commercial)** (Società semplice)	**General partnership (commercial)** (Società in nome collettivo)	**Joint-stock company** (Società per azioni)	**Private limited company** (Società a responsabilità limitata)	**Publicly traded partnership** (Società in accomandita per azioni)	**Limited partnership** (Società in accomandita semplice)	**Cooperative** (Società cooperative)
Share- holder	1	≥ 2	≥ 2	≥ 1	≥ 1	≥ 2	≥ 2	≥ 3 if natural person, otherwise ≥9
Capital deposit	0	> 0	> 0	≥ 50,000 €	≥ 10,000 € If simplified ≥ 1 € and ≤ 9.999 €	≥ 50,000€	> 0	> 0
Liability	Owner is 100% liable (business and personal)	Each shareholder has a maximum liability unless otherwise agreed	Each shareholder has a maximum liability	Of the company	Each partner has a maximum liability as large as his or her participation	Each partner has a maximum liability as large as his or her participation	Each partner has a maximum liability as large as his or her participation	Of the company

	Sole trader	Company						
	Sole trader	Partnership		Corporation			Limited Partnership	Cooperative
	Sole trader (Imprenditore individuale)	**General partnership (non-commercial)** (Società semplice)	**General partnership (commercial)** (Società in nome collettivo)	**Joint-stock company** (Società per azioni)	**Private limited company** (Società a responsabilità limitata)	**Publicly traded partnership** (Società in accomandita per azioni)	**Limited partnership** (Società in accomandita semplice)	**Cooperative** (Società cooperative)
Assessment/ important criteria	--	At least one of the partners must have the IAP or CD qualification	At least one of the partners must have the IAP or CD qualification	The administrator must have the IAP or CD qualification	The administrator must have the IAP or CD qualification	The administrator must have the IAP or CD qualification	At least one of the partners must have the IAP or CD qualification	The administrator must have the IAP or CD qualification and must be a member of the cooperative
		The corporate object in the company statute must be the exclusive exercise of agricultural activities as in art. 2135cc	The corporate object in the company statute must be the exclusive exercise of agricultural activities as in art. 2135cc	The corporate object in the company statute must be the exclusive exercise of agricultural activities as in art. 2135cc	The corporate object in the company statute must be the exclusive exercise of agricultural activities as in art. 2135cc	The corporate object in the company statute must be the exclusive exercise of agricultural activities as in art. 2135cc	The corporate object in the company statute must be the exclusive exercise of agricultural activities as in art. 2135cc	The corporate object in the company statute must be the exclusive exercise of agricultural activities as in art. 2135cc

Notes: The IAP qualification stands for "imprenditore agricolo professionale" see D.lgs 99/2004 art.1.; CD qualification stands for "coltivatore diretto" see L. n. 9/1963.

3.1.5.1. TAXATION

Practically, there are connexed activites with the agricultural one, on which there is a tax exemption. Among them, there is electricity and heat production from renewable energies, including biogas, biofuels and chemicals, if more than 50% is being produces from materials coming from the land cultivated by the farmer (Law n. 266 del 23/12/2005). The percentage is made comparing the value or the energetic content of the material coming from farming activities of the owner of the renewable energy production system.

With the approvation of D.L. 88/2014 the activities of electricity and heat production from renewable energies, including biogas, biofuels and chemicals will not be included in tax exemption anymore. Therefore these activities will be subjected to VAT taxation if the plant nominal power is below 300 kW.

3.1.5.2. THE ESCO

An energy service company (acronym: ESCO or ESCo) is a commercial business providing a broad range of comprehensive energy solutions including designs and implementation of energy savings projects, energy conservation, energy infrastructure outsourcing, power generation and energy supply, and risk management.

Energy Service Companies (ESCOs) are an experienced and effective delivery mechanism to provide the maximum amount of energy efficiency resources. Organizations often turn to ESCOs when considering retrofit projects since ESCOs have extensive design and implementation experience in integrating multiple efficiency measures, mitigating technical and performance risks, and providing a financial guarantee to project lenders that the energy savings generated will cover the debt service.

A newer breed of ESCO evolving in the EU now focusses more on innovative financing methods. In all instances, The ESCO starts by performing an in-depth analysis of the property, sometimes at risk, designs an energy efficient solution, installs the required elements, and maintains the system to ensure energy savings during the payback period. The savings in energy costs are often used to pay back the capital investment of the project over a five- to twenty-year period, or reinvested into the building to allow for capital upgrades that may otherwise be unfeasible. If the project does not provide returns on the investment, the ESCO is often responsible to pay the difference [NAESCO 2014].

3.1.6. Poland

Table 11: Characterization of the most relevant legal forms of company for biogas projects in Poland [Companies Code 2014 , Civil Code 2014, Income Tax Act 2012, Income Tax Act 2014, MinEconomy 2014]

	General Partnership (spó1ka jawna, sp. j.)	**Limited Partnership** (spó1ka komandytowa, sp. k.)	**Partnership Limited by Shares** (spó1ka komandytowo-akcyjna, S.K.A.)	**Limited Liability Company** (spó1ka z ograniczonq odpowiedzi-alnosciq,	**Joint-Stock Company** (spó1ka akcyjna, S.A.)	**Cooperative** (spó1dzielnia)	**Partnership** (spó1ka cywilna, s.c.)	**Individual entrepreneur** (indywidualny przedsibiorca)
Shareholder	At least two natural or legal persons.	At least two persons, one general partner and another limited partner.	At least two persons, one general partner and another passive investor.	One or several natural or legal persons or organizational units without legal personality, but no one–man Limited Liability Company	One or several natural or legal persons or organizational units without legal personality, but no one–man Limited Liability Company	At least ten natural persons or three legal persons (in case of agricultural production cooperative at least five natural persons)	Two or three natural or legal persons.	Natural person.
Capital deposit	Amount is not stipulated.	Amount is not stipulated.	At least PLN 50,000.	At least PLN 5,000 (the minimum value of the share is PLN 50).	At least PLN 100,000 (the min. value of the share is PLN 0.01). The capital deposit is divided into shares of equal value. These shares can be traded on the stock market.	Amount may be stipulated in the agreement.	Amount is not stipulated.	No capital deposit.

	General Partnership (spó1ka jawna, sp. j.)	**Limited Partnership** (spó1ka komandytowa, sp. k.)	**Partnership Limited by Shares** (spó1ka komandytowo-akcyjna, S.K.A.)	**Limited Liability Company** (spó1ka z ograniczonq odpowiedzi-alnosciq,	**Joint-Stock Company** (spó1ka akcyjna, S.A.)	**Cooperative** (spó1dzielnia)	**Partnership** (spó1ka cywilna, s.c.)	**Individual entrepreneur** (indywidualny przedsibiorca)
Liability	All partners are liable with their whole capital for all obligations of the company.	General partner is totally liable, limited partner is only liable with the sum of the partnership specified in the text of the agreement of Limited Partnership.	General partner is totally liable. Investor is liable only in case when his name will be placed in the name of the company, and when he makes a legal action on behalf of the company without proxy.	Limited Liability Company is liable with the whole capital of the company. Liability of the company is limited to the share capital, meaning that partners only are liable with their deposit/ investment (if execution against the company proves to be ineffective, for the liabilities of the company may be responsible members of the Board).	Joint-Stock Company is liable with the whole capital of the company. Liability of the company is limited to the share capital, meaning that partners only are liable with their investment.	Liability of the cooperative is limited to the share capital, meaning that members only are liable with their investment.	All partners are liable with their whole capital for all obligations of the company.	Total capital of the entrepreneur.
Legal capacity	Organizational unit without legal personality.	Organizational unit without legal personality.	Organizational unit without legal personality.	Legal person.	Legal person.	Legal person	Partnership does not have legal personality - is the construction regulated by the law of obligations.	Natural person.

	General Partnership (spó1ka jawna, sp. j.)	**Limited Partnership** (spó1ka komandytowa, sp. k.)	**Partnership Limited by Shares** (spó1ka komandytowo-akcyjna, S.K.A.)	**Limited Liability Company** (spó1ka z ograniczonq odpowiedzi-alnosciq,	**Joint-Stock Company** (spó1ka akcyjna, S.A.)	**Cooperative** (spó1dzielnia)	**Partnership** (spó1ka cywilna, s.c.)	**Individual entrepreneur** (indywidualny przedsibiorca)
Management/ represent-tation	All members of the society are legitimated and obliged to manage without additional compensation (the company can be managed by one or more shareholders if it will be decided in agreement or a subsequent resolution of the company's shareholders).	Only the general partner is entitled and obliged to manage and represent. Limited partner may represent the company only as a proxy.	Only the general partner is entitled and obliged to manage and represent. Limited partner may represent the company only as a proxy.	Is represented by the management of one or more members who are natural persons. Members of the society have no right of representation. The member of the management can be a member of the society or someone from outside.	Is represented by the management of one or more members. Members of the society have no right of representation. The management is controlled by the Board.	Is managed by the management of one or members. The management is controlled by the Board.	All members of the society are legitimated and obliged to manage without additional compensation.	Individual entrepreneur is manager and representative of the company.
Taxation	Only commercial taxation of members – they are taxable with their profit share. There is no company income tax.	Only commercial taxation of members – they are taxable with their profit share. There is no company income tax.	Only commercial taxation of members – they are taxable with their profit share. There is no company income tax. The company is liable to VAT.	Double taxation: income tax from legal person and tax on dividends paid to shareholders.	Income tax from legal person.	Tax on dividends paid to shareholders.	Only commercial taxation of members – they are taxable with their profit share. There is no company income tax. The company is liable to VAT.	Commercial taxation of individual entrepreneur.

	General Partnership (spó1ka jawna, sp. j.)	**Limited Partnership** (spó1ka komandytowa, sp. k.)	**Partnership Limited by Shares** (spó1ka komandytowo-akcyjna, S.K.A.)	**Limited Liability Company** (spó1ka z ograniczonq odpowiedzi-alnosciq,	**Joint-Stock Company** (spó1ka akcyjna, S.A.)	**Cooperative** (spó1dzielnia)	**Partnership** (spó1ka cywilna, s.c.)	**Individual entrepreneur** (indywidualny przedsibiorca)
Assessment/ important criteria	▪ Without minimum capital. ▪ Liability risk (members of the company are liable with partnership capital and private capital). ▪ High reputation because of personal liability. ▪ Relatively low costs of bookkeeping (the partnership does not have to keep full cost accounting).	▪ For entrepreneurs that are looking for further initial capital, but want to stay with sole responsibility. ▪ General partner manages business alone. ▪ Limited partner is financially involved with the company. ▪ The total liability of the general partner. ▪ Limited partners are liable only with the specified earlier sum of the partnership. ▪ Relatively high costs of bookkeeping (the necessity of keeping full cost accounting).	▪ For entrepreneurs that are looking for further initial capital, but want to stay with sole responsibility. ▪ General partner manages businesses alone. ▪ The total liability of the general partner involves also his private capital. ▪ There is no liability risk for investor. ▪ Relatively high costs of bookkeeping (the necessity of keeping full cost accounting).	▪ Company is liable with the whole company capital. ▪ Liability of members is limited to their own investment. ▪ Relatively high costs of registration and bookkeeping (the necessity of keeping full cost accounting and the preparation of financial statements at year-end).	▪ Company is liable with the whole company capital. ▪ Liability of members is limited to their own investment. ▪ Relatively high costs of bookkeeping (the necessity of keeping full cost accounting, the preparation of financial statements at year-end and audit).	▪ The association has no profit prospects. Profits are divided between the members. ▪ Liability of members is limited to their own investment.	▪ Without minimum capital. ▪ Liability risk (members of the company are liable with partnership capital and private capital). ▪ High reputation because of personal liability. ▪ Relatively low costs of bookkeeping (simplified).	▪ Without capital deposit. ▪ Liability risk (entrepreneur is liable with capital and private capital). ▪ High reputation because of personal liability. ▪ Low costs of registration and bookkeeping (simplified). ▪ Entrepreneur himself makes all decision.

3.1.7. The Netherlands

Table 12: Characterization of the most relevant legal forms of company for biogas projects in the Netherlands [KvK 2014, SCHOONE 2014]

	Sole trader (eenmans zaak)	**General partnership** (VOF)	**Limited partnership** (CV)	**Professional partnership** (maatschap)	**Private limited company** (BV)	**Co-operative society** (coöperatie)
Shareholder	One natural or legal person	At least two natural or legal persons.	At least two natural or legal persons.	At least two natural or legal persons.	One or several natural or legal persons.	At least two natural or legal persons.
Capital deposit	None	None	None	None.	At least €18,000	None.
Liability	Owner is 100% liable (business and personal)	Each partner is liable (business and personal)	Active partners are liable for obligations. Silent partners are liable for the amount they invest.	Each partner is liable for the obligations of the partnership but not for the individual obligations of the partners.	Each shareholder has a maximum liability as large as its participation in the BV	The cooperation is liable; its members are equally liable. Exclusion of personal liability is possible with specific subtypes cooperation with limited liability' or cooperation without liability.
Legal capacity	No legal form	No legal form	No legal form	No legal form	Legal form	Legal form

	Sole trader (eenmans zaak)	**General partnership** (VOF)	**Limited partnership** (CV)	**Professional partnership** (maatschap)	**Private limited company** (BV)	**Co-operative society** (coöperatie)
Management/ representation	Owner	All partners represent the VOF or dependent on the VOF contract.	Management by the active partners	All partners represent the partnership	Board of directors	Management chosen by the members
Taxation	Income tax, turnover tax	Income tax on each person's share of the profit. Turnover tax.	Income tax, turnover tax. Active partners: on their share of the profits. Silent partners: on renumeration received	Income tax on each person's share of the profit. Turnover tax.	Wealth tax on the capital, corporation tax on the profit, turnover tax.	Income tax, Turnover tax
Assessment/ important criteria	No minimum capital Offers tax advantages when the income is low High reputation because of personal liability.	No minimum capital Offers tax advantages when the income is low High reputation because of personal liability.	No minimum capital High reputation because of personal liability.	No minimum capital	Minimum capital required No personal liability Offers tax advantages when the income is high.	No minimum capital

3.2. Proceeding of permits

3.2.1. Belgium

The proceedings of permit will be documented separately for wood combustion plants and biogas plants, but both have the same basis. In Belgium every project for building a business premise of noisy or noxious trade has to obtain two important permits: an environmental permit and a building permit. Since 1st January 2010 these two permits can be applied for at the same place.

3.2.1.1. ENVIRONMENTAL PERMIT [OAVM 2014, VLM 2014]

The VLAREM I legislation states the conditions for which type of business permits or notifications are required. An environmental permit integrates different kind of permits like an exploitation permit, license for maximum admissible discharges, license for the destruction of toxic waste, license to dispose waste etc.

The full procedure is described in the VLAREM 2 legislation and divides businesses premise of noisy or noxious trade into three classes. Businesses with a large polluting potential are classified under class 1. Those in class 2 are less troublesome, and those in class 3 the least. Class 1 businesses have to file an application for a permit with the province, whereas class 2 businesses have to do so with the college of Aldermen. Class 3 businesses do not have to apply for a permit, only a notification is required. All the possible types of businesses of noisy or noxious state are described in different sections.

The micro scale digesters that are currently placed in Belgium are categorised in Class III. There is only a notification requirement which makes it easy to acquire. The notification is an announcement of a change in the production process in section 9 of Vlarem III.

3.2.1.2. BUILDING PERMIT [OAVM 2014, VLM 2014]

Larger project with significant impact who are obliged to make an environmental effect study or need two or more advices have to make a project study and apply for a project meeting.

The fermentation tank and digestate storage need a building permit. The underground needs a hardening and the installation must be easily adapted to future expansions.

Terms:

- digester is built according to the rules of good workmanship
- under the supervision and according to the guidelines of an architect or civil engineer, architect or civil engineer or an industrial engineer in architecture
- for installations licensed from July 1, 2014, after completion of construction, a certificate issued by the aforementioned expert delivered showing that the works were carried out according to the rules of good workmanship
- certificate is kept available for inspection by the regulator.

3.2.2. Denmark

Local municipalities form the authority if farmers or companies apply for approval of installation of micro scale biogas plants.

An on farm plant would normally be recognized as a part of the agricultural business, and would not in general cause any problems. However a so-called screening for optional environmental impacts has to be carried out and sometimes also a specific estimation of environmental impacts has to be elaborated, which is both costly and time consuming. This is normally seen by larger plants.

The project must comply with the regulations in the below legal documents:

- Planloven (lov nr. 553 af 1. Juni 2011)
- Miljøbeskyttelsesloven (bekendtgørelse nr. 1640 af 13.12.2006)
- Naturbeskyttelsesloven (Bekendtgørelse nr. 933 af 24. september 2009
- Bekendtgørelse om erhvervsmæssigt dyrehold, husdyrhold og ensilage mv, 2014
- If the plant is due to receive animal biproducts;

  Biproduktforordningen (EF 1774/2002 af 3. Oktober 2002).

The regulatory regime for approval of a biogas plant is described in detail in the publication [KOGEBOG 2012].

In addition the project must meet the requirements in regulations of safetty in general and work safety. Authorities in this field are Arbejdstilsynet and Sikkerhedsstyrelsen. The below regulations must be met [ERIKSEN 2011]:

- Lov om gasinstallationer og installationer i forbindelse med vand-og afløbsledninger, lovbekendtgørelse nr. 988 af 8. december 2003
  - Af §2 stk.1 pkt. 2 fremgår:

    Produktionsanlæg, distributionsledninger og øvrige anlæg til forsyning af gas til de i nr. 1 nævnte gasinstallationer, medmindre gassikkerheden ved disse anlæg er omfattet af lov om arbejdsmiljø.
- 1674 af 14/12 2006. Bek. om autorisation og drift af virksomhed som vvs-installatør, vand- og sanitetsmester, godkendt kompetent virksomhed eller kloakmester
- 1653 af 13/12 2006. Bek. om personlige faglige kvalifikationer for den teknisk ansvarlige og dennes medarbejdere i autoriserede og godkendte kompetente virksomheder
- 1046 af 08/12 2003. Bek. om undtagelser fra krav om autorisation for så vidt angår gas-og vandforsyningsvirksomheder og ejere af afløbsanlæg
- Gasreglementet.

3.2.3. France

3.2.3.1. EXPLOITATION PERMIT OR ENVIRONMENTAL PERMIT

An anaerobic digestion plant is an installation classified in conformance with the environmental protection regulation (ICPE). According to the impact intensity on the environment, three regimes can apply: Declaration, Recording and Authorization.

An AD plant is concerned by section 2781 and possibly by the sections 2910-C and 2171

Section 2781: **AD plants of non-hazardous waste or raw vegetable material, with the exception of the installations of waste water or urban sewage sludge when they are fermented on their production site**

1. Anaerobic Digestion of raw vegetable material, livestock manure, stercoral matter, vegetable waste of food-processing industries	Regime
a) Quantity of treated materials being superior or equal to 50 tonne/day	Authorization
b) Quantity of treated materials being superior or equal to 30 tonne/day and inferior to 50 tonne/day	Recording
c) Quantity of treated materials being inferior to 30 tonne/day	Declaration
Anaerobic Digestion of other non-hazardous waste	Authorization

Section 2910-C: **Combustion** with the exception of the installations aimed by the sections 2770 and 2270

C - When the installation consumes exclusively biogas of the AD plant classified under the section 2781-1 and if the maximal thermal power of the installation is superior to 0,1 MW	Regime
When the biogas is produced by an installation submitted to Authorization or by several installations classified in conformance with the section 2781-1	Authorization
When the biogas is produced by only one installation submitted to Recording classified in conformance with the section 2781-1	Recording
When the biogas is produced by only one installation submitted to Declaration classified in conformance with the section 2781-1	Declaration with periodic controls

Section 2171: **Deposit** of manure, fertilizers and support of culture containing organic matters and **not being the appendix of a farm**

Deposit superior to 200 m3	Recording

Furthermore, as soon as there is introduction of animal by-products, including manure and slurry, it is essential to deposit a request for the approval in conformance with the European regulation (CE) n°1069/2009 of October 21st, 2009, establishing the sanitary rules applicable to the animal by-products not intended for the human consumption. This request must be made with the Prefecture.

3.2.3.2. BUILDING PERMIT

An AD plant is submitted to a town-planning permit (Building permit). The AD plant can be considered as an industrial plant or as an agricultural plant.

The delivery of the building permit is the Mayor competence, if the municipality has a land use plan or a Local Urbanism Plan. Otherwise, the building permit is instructed by the state.

If the AD plant is exploited and the energy marketed by a farmer or a grouping of majority farmers in a non-trading company and uses raw materials coming for 50 % of the agriculture, this plant can see granting this authorization by dispensation, in agricultural zone of a municipality endowed with a document of town planning either in zone not yet urbanized by a municipality have a Local Urbanism Plan or a Plan in zone not yet urbanized by a municipality submitted to the town planning national regulation, from then on the requester will have been able to prove the necessity of this equipment for the farm.

The recent regulations modify appreciably the deadlines of build permit instruction : the deadlines are globally increased but the transparency of the procedure is increased. The instruction deadline is fixed to three months by the article R.423-3 of the planning laws but can be carried in six months if some departmental or regional comissions must be consulted.

Let us note that if no decision was sent to the requester in the date of delivery, the permit is tacitly delivered.

Besides, the permit can be disputed by a third with the administration and with the administrative court by appealing in two months following the notification display on the construction site.

In the case of heat sale and creation of a private heat grid, it will be necessary to make an authorization request of occupation of the public domain as well as authorizations request of passage on the private domains.

If the produced energy is mainly resold, the project can be likened to an equipment of collective interest. So the project can be envisaged whatever is the zoning (unless the equipments of collective interest are forbidden or if the nuisances and the constraints which it implies make it incompatible with the existing activities).

The two requests, Exploitation permit and Building permit are linked. It is advisable to deposit the authorization request to exploit in the first one. A receipt of request is then delivered, even if the justification of application for build permit is missing. The master of work can then deposit a complete request of building permit. The confirmation of receipt delivered by the town hall on this occasion must be then transmitted in the prefecture for instruction of the exploitation permit in the next 10 days.

3.2.3.3. THE SANITARY APPLICATION FOR APPROVAL IN THE CASE OF ANIMAL BY-PRODUCTS USE

As a general rule the sanitary approval in conformance with the regulation (CE) n°1774 / 2002 is required for the AD plants using as raw material, alone or in mixture, animal by-products of category 2 or category 3. In fact, the sanitary approval is required for all the AD plants using animal by-products, included manure.

Animal by-products of category 2 present a risk for the animal health. It is in particular about monogastric animals corpses and about slurry. These by-products can be valued with the aim of certain uses other than the animals food after sterilizing treatments.

Animal by-products of category 3 not presenting sanitary risks and include in particular parts of brought down animals fit for human consumption. These by-products can be used in animal feed and for technical uses. They also understand in the new regulation 1069/2009, waste of cooking and table intended to produce some compost and biogas.

Sanitary approvals is delivered by the prefect of the department, on proposal of the departmental director of the protection of the populations (DDPP).

However for the AD plants using exclusively liquid manure, some milk, colostrum, stercoraceous materials, the approval as establishment of production of biogas is required (article 24.1 g° by the regulation (CE) n°1069 / 2099). In this case the AD plant does not have to meet the requirements regarding transformation of animal by-product (hygienization / pasteurization) as well as the microbiological criteria defined in the regulation (CE) n°0169 / 2009.

3.2.3.4. RIGHT OPENING CERTIFICATE FOR THE FEED IN TARIFF

It is a right for the producer of electricity which is formalized by the obtaining of a certificate for the feed in tariff. For it the producer has to send a request case to the prefect of region (DREAL) including elements enumerated in the decree n°2001-410 of May 10th, 2001.

The producer has to sell the entire electricity production, deduction made possibly by the autoconsummate part. However the price of the feed in tariff returns most of the time the autoconsumption not interesting economically.

3.2.3.5. THE REQUEST OF CONNECTING FOR THE PUBLIC ELECTRICITY GRID

The request of connecting is necessary for any new installation. It is made with one of the grid managers according to the connecting tension (articles L.342-1 to L.342-12 of the code of the Energy and decree n°2003-588 of June 27th, 2003). Further to the answer of the grid manager to request for the first information of the producer, a detailed connecting study is realized subject to the building permit notification (the technical and financial proposal or PTF) in one lapses of three months.

Once the PTF was accepted by the producer, the later stages for the grid connecting are:

- The technical agreement of connecting (fix the deadline and the costs of the connecting)
- The operating agreement (described the exploitation modalities of the works of connecting)
- The electric feed in tariff contract

Let us indicate that the cost of the connecting stays chargeable to the producer of electricity.

To note that for the plants of the power subordinates or equal in 36 kVA (connecting in low voltage), the agreements are joined into a single contract.

3.2.4. Germany

For the approval of biogas plants there have to be considered a lot of laws and orders. These legal demands consider various regulations such as project planning rights, building regulations, protection against pollution regulations, water, nature, waste, fertilizer and hygiene regulations and laws to examine their environmental compatibility. Beside this, the epizootic diseases act laws could play a roll, if there are used animal by-products in the plant. It has to be considered that the action of approval is different for each federal state. The abundance of laws for the approval procedure and the different specific federal state bases clearly show that it is advisable to consult an expert for the approval process [FNR 2013].

For the approval of a biogas plant two procedures can be distinguished: The building regulation procedure or the extensive procedure of the Federal Immission Control Act (Bundesimmssionsschutzgesetz (BImschG)) [FNR 2013]. The main criterion to determine the relevant approval procedure is the annual production rate of raw biogas. Below a threshold of 1.2 Mio. m³/a – which corresponds to an installed electric CHP power of approx. 270 kW – the building permission by the Construction law is sufficient. For small digesters this is the predominant approval procedure.

Each Federal State has its own building regulation (Landesbauordnung) that specifies the actual procedure and the required documents. With the building application the applicant usually hands in documents, maps and drafts concerning:

- general information on the involved landscape, construction site and its owner
- architectural drawing including site layout, views and sections of the biogas plant, etc
- the feedstock for the biogas plant
- calculations of the expected gas production rate,
- process description including the gas holder and the CHP unit
- description of start-up process
- emission control
- safety issues (fire safety, worker health and safety)
- use of digestate
- precautions for dismantling the plant after end of service life
- etc.

During the planning process the local power company should be contacted to inform them about the ongoing plans for a biogas plant and to inquire the connection point for the biogas plant to the electricity grid. Since the power companies have to connect renewable energy plants to the grid according to the German EEG an official permit for grid connection is not required.

3.2.4.1. FURTHER INFORMATION

You can find more information on the Biogas Manual ("Leitfaden Biogas") and in the Bavarian Biogas Manual ("Biogashandbuch Bayern"). Though the latter specifically describes the building permit application in Bavaria, it provides a sound overview and the basic principle is also applicable in other states.

- Acts and Ordinances:

  http://www.gesetze-im-internet.de
- General information:

  http://www.carmen-ev.de/infothek/rechtlicher-rahmen/gesetze-verordnungen

http://biogas.fnr.de/rahmenbedingungen/rahmenbedingungen2/

- Biogashandbuch Bayern:

  http://www.lfu.bayern.de/energie/biogashandbuch/index.htm

3.2.5. Italy

The authorisation procedure for the production of electricity from renewable energy sources currently in force was introduced by Legislative Decree No 387/2003, implementing Directive 2001/77/EC. Article 12 of this regulation provides that the construction and operation of electricity production plants powered by renewable sources, and modification, expansion, total or partial reconstruction, and reactivation operations and connected works, as well as those connected to infrastructure essential for the construction and operation of the same plants are subject to a single authorisation. This document concludes a procedure lasting a maximum of 180 days. This value was reduced to 90 day by Legislative Decree No 28/2011.

The main aim of introducing this procedure was the rationalisation and simplification of the authorisation procedure for production plants using renewable sources. In fact, the single authorisation is issued in accordance with the current regulations for the protection of the environment, landscape and historical / artistic heritage within a single procedure in which all the authorities concerned participate. Where necessary, the plant and connected infrastructure must comply with environmental impact assessment regulations.

The single authorisation grants the right to construct and operate the plant in accordance with the approved plans and, where necessary, with the declaration of public interest, necessity and urgency. The single authorisation is in itself a change to the urban planning instrument. The requirements of countryside protection plans remain mandatory.

The authorisation cites any conditions applicable to the construction and operation of the plant; it also defines the procedures to be followed for the rehabilitation of the site once the plant is decommissioned (or, for hydroelectric plants, procedures for fulfilling the obligation to take environmental recovery and reintegration measures).

The single authorisation sets deadlines for the start and end of works, and once these have passed the authorisation ceases to be effective, unless it is extended.

Article 12 of Legislative Decree No 387/2003 provides for a simplified procedure; this simplified procedure applies to plants with a generation capacity below the thresholds indicated in Table 13 included in an annex to Legislative Decree No 387/2003 and reproduced below:

Table 13: Thresholds for simplified procedure subject to the regulation No 387/2003for certain technologies and plant generation capacity

Technology	Threshold (kW)
Wind	60
Solar photovoltaic	20
Hydraulic	100
Biomass	200
Landfill gas, residual gases from purification processes and biogas	250

For plants which do not exceed the thresholds indicated above, the enabler simplified procedure requirement applies in accordance with Legislative Decree No 28/2011. A decree from the Ministry for Economic Development, in consultation with the Ministry for the Environment, Land and Sea and in agreement with the Unified Conference, could define higher generation capacity thresholds and additional installation site characteristics to which the same commencement notice requirement would apply. The Community Law of 2009 made the Italian Government responsible for extending the use of commencement notices to renewable energy plants with a capacity below 1 MW.

According to the specific type of works to be carried out, some of the authorization procedures indicated in the table above and described in more detail below could also foresee the completion of the environmental impact assessment procedure. More specifically, these are the types of operation covered by Legislative Decree No 152/2006:

Projects subject to environmental impact assessment for which the State is responsible:

- power plants and other combustion plants with a heating capacity of at least 300 MW
- off-shore wind power installations
- hydroelectric power plants with installed capacity greater than 30 MW
- installations to be used to hold back, regulate and accumulate water in a sustainable way for energy purposes, of a height greater than 10 m or which have a storage volume greater than 100,000 m^3
- overhead electric power lines with nominal operational voltage above 150 kV and longer than 15 km
- electric power lines in buried AC cables, and longer than 40 km.

Projects subject to environmental impact assessment for which the region is responsible:

- power plants for the production of electricity, steam and hot water with total heat capacity greater than 150 MW
- on-shore wind power installations. A representative of the Italian Ministry for Cultural Heritage and Activities must be involved in the procedure for such projects
- incineration plants for non-hazardous waste, with capacity greater than 100 t/day
- overhead electric power lines with nominal voltage above 100 kV and longer than 10 km.

Projects subject to applicability screening for which the region is responsible:

- power plants for the production of electricity, steam and hot water with total heat capacity greater than 50 MW
- non-thermal industrial installations for the production of electricity, steam and hot water with total capacity greater than 1 MW
- industrial installations for the transportation of gas, steam and hot water which supply pipes with a total length greater than 20 km
- wind power installations with total capacity greater than 1 MW
- hydroelectric power plants with installed capacity greater than 100 kW
- incineration plants for non-hazardous waste, with total capacity greater than 10 t/day
- overhead electric power lines with nominal voltage above 100 kV and longer than 3 km.

For the implementation of plans and schemes which may have a significant environmental impact (including, for example, the Electricity Network Development Plan), Legislative Decree No 152/2006 also provides for screening for the applicability of the Strategic Environmental Assessment (SEA) defined under Directive 2001/42/EC.

3.2.5.1. CONNECTION TO THE ELECTRICITY NETWORK

Legislative Decree No 79/1999, transposing European Directive 96/92/EC, establishes the obligation for distribution companies to connect all parties which request it to their own networks, without compromising the continuity of service.

For renewable energy plants, Legislative Decree No 387/2003, transposing European Directive 2001/77/EC, deals with issues relating to the connection of plants to the electricity network.

For high-efficiency cogeneration plants, the legislative reference for the connection service is Legislative Decree No 20/2007.

The regulation in force (AEEG Decision No ARG/elt 99/08 - Compendium of Rules for Active Connections (TICA)) defines the procedural methods and technical / financial conditions for connection to the electricity networks, with the obligation to connect third-party production plants. With regard to low and medium voltage networks, the TICA specifies connection charges based on the distance from the connection point to the network, the capacity of the connection and the type of connection. These charges only apply to plants using renewable energy sources (RES) and high-efficiency cogeneration (HEC). Conventional plants refer to the conditions published by each operator and must pay the TICA charges or the operator's charges, whichever is higher.

For connections to high and very high voltage networks, the TICA does not set specific charges but requires the application of a reduction in the payments due for RES and HEC plants.

The contractual terms and conditions (CTCs) for the provision of this service are defined and published by each individual network operator. The CTCs define the conventional technical solutions adopted by the network operator to create the connection, the arrangements and response times, payments terms for the connection charges, and criteria for establishing the charges in order to cover the costs incurred by the network operator in managing the authorisation procedure.

The regulation also covers the resolution of disputes between producers and network operators, specifically relating to the connection of RES plants. Technical rules for the connection service

The reference technical rules for connection differ according to whether the connection is to a low voltage network (up to 1 kV) or to a higher voltage network.

For network voltages above 1 kV, AEEG Decision No ARG/elt 33/08 "Technical conditions for connection to electricity distribution networks with a nominal voltage above 1 kV: Single technical rule for medium / high / very high voltage connections" recognises standard CEI 0-16 as the standard to which all network operators must refer when defining the connection project. The anticipated maximum values for connection capacity, depending on the network voltage, are the following:

Table 14: Reference technical rules for net connection

Network voltage	Plant capacity
Low (< 1 kV)	< 100 kVA
Medium (< 35 kV)	< 6000 kVA

The local network operator will manage the connection procedure for the producer up to a connection capacity of 10 MVA. New energy producers intending to be connected to the electricity network can refer to the TICA.

For low and medium voltage connections, the deadlines for preparing the connection estimate, starting from the date on which the connection request is received, are the following:

- 20 working days for feed-in capacities up to 100 kW

- 45 working days for feed-in capacities between 100 kW and 1,000 kW
- 60 working days for feed-in capacities higher than 1,000 kW.

The estimate is valid for 45 working days and gives a list of the works which are strictly necessary in order to physically create the connection, which the applicant must make available at the connection point. The estimate must indicate the payment due for the connection, highlighting the portion, equal to 30% of the total, which the applicant must pay when it accepts the estimate, and the remaining portion which the applicant must pay after the completion of the necessary works to prepare the network installation infrastructure for the connection at the connection point.

The timeframe for completing the connection is 30 working days for simple works and 90 working days for complex works, increased by 15 working days for each kilometre of power line to be constructed at medium voltage, after the first kilometre.

When the connection installation has been completed, the distributor company announces this and declares that the connection can be brought into operation.

If, in order to create the connection, it proves necessary to carry out operations on the high voltage network, the timeframe for completing the connection is indicated by the distributor company in the connection estimate.

3.2.5.2. RES-E ("IAFR") QUALIFICATION OF PLANTS

The qualification of plants as plants using renewable energy sources ("IAFR" – RES-E) is a pre-requisite to obtain green certificates or the all-inclusive feed-in tariff.

Eligible plants include:

- new, upgraded/repowered, totally/partially renovated and reactivated plants that have been commissioned after 1 April 1999;
- co-firing plants that have been commissioned before 1 April 1999 and have operated as hybrid plants after such date.

Apart from for a few exceptions specified in the Ministerial Decree of 18 Dec. 2008, photovoltaic plants are not eligible for these forms of support, as they only benefit from the support referred to in the Ministerial Decree of 19 Dec. 2007 (PV feed-in scheme).

Starting in 2009, under the Ministerial Decree of 18 December 2008, plant owners are required to pay a contribution (based on the average yearly capacity of their plant) to the costs incurred by GSE for the qualification procedure.

The producer must submit an appropriate application, accompanied by the required technical documents, to GSE to apply for the RES-E qualification.

3.2.6. Poland

The construction and operation of bioenergy plants require obtaining a number of decisions. Some of them are common for biogas and wood combustion plants, some refer to a specific type of plant. Therefore below permits are included in one table with the determination of plant's type. In the table also is posted which law is regulated the permit.

Table 15: Overview of permits connected with environmental protection referring to specific type of plant and legal origin of regulation

Permits	Plant's type description	Law
Decision on the environmental conditions	For biogas plants where amount of energy introduced to the system fuel is at least 25 MW	Act of Parliament of the 27th April, 2001 Environmental Law (OJ No 62, item 627 as amended) Regulation of the Council of Ministers of November 11, 2010 on projects which are likely to have a significant effect on the environment (OJ No 213, item 1397)
Decision to permit release of gases or dust into the air	For biogas plants where amount of energy introduced to the system fuel is greater than 15 MW	Act on Waste of the 27th April, 2001 (OJ No 62, item 628 as amended) Regulation of the Minister for the Environment of the 2nd July, 2010 on cases when release of gases or dust into the air from installation does not require permit (OJ No 130, item 881)
Application due to the release of gases or dust into the air	For biogas plants where amount of energy introduced to the system fuel is greater than 1 MW and lower or equal to 15 MW	Act on Waste of the 27th April, 2001 (OJ No 62, item 628 as amended) Regulation of the Minister for the Environment of 2nd July, 2010 on installation types which requires application for operation (ON No 130, item 880)
Decision to permit the waste recovery by R10	For biogas plants where waste are spreading on the ground for fertilization or soil improvers	Act on Waste of the 27th April, 2001 (OJ No 62, item 628 as amended)
Decision to permit the waste recovery by R3	For biogas plants	Act on Waste of the 27th April, 2001 (OJ No 62, item 628 as amended)

Table 16: Overview of permits connected with construction referring to specific type of plant and legal origin of regulation [Ure 2014, MinEconomy 2014, MinAgriculture 2014]

Permits	Plant's type description	Law
Building permit decision ▪ In the absence of local development plan first obtaining decision of conditions for construction and land management ▪ Before the application must be obtained: terms of grid connection, terms of rainwater drainage, terms of connection to water supply, terms of sewage	For biogas plants	▪ Act of Parliament of the 7th July, 1994 Construction Law (OJ No 89, item 414 as amended) ▪ Act of Parliament of the 27th April, 2001 Environmental Law (OJ No 62, item 627 as amended) ▪ Act of Parliament of the 10th April, 1997 Energy Law (OJ No 54, item 348 as amended)
Decision of the technical inspection on operation of pressure (closed) boilers and tanks	For tanks in biogas plants	▪ Act of Parliament of the 21st December, 2000 on the Technical Inspection (OJ No 122, item 1321 as amended) ▪ Regulation of the Council of Ministers of 16th July, 2002 on the kinds of devices subjected to the technical inspection (OJ No 120, item 1021 as amended)

Table 17: Overview of permits connected with operation referring to specific type of plant and legal origin of regulation

Permits	Plant's type description	Law
Use permit decision	For biogas plants	Act of Parliament of the 7th July, 1994 Construction Law (OJ No 89, item 414 as amended)
Entry in the register of energy companies involved in the production of agricultural biogas	For agricultural biogas plants	Act of Parliament of the 10th April, 1997 Energy Law (OJ No 54, item 348 as amended)
Concession for electricity production	For not agricultural biogas plants	Act of Parliament of the 10th April, 1997 Energy Law (OJ No 54, item 348 as amended)
Concession for heat production	Biogas plants of installed thermal power greater than 5 MW	Act of Parliament of the 10th April, 1997 Energy Law (OJ No 54, item 348 as amended)

3.2.7. The Netherlands

For the approval of the permit for a biogas plants a lot of laws and orders have to be considered. The InfoMil "Handreiking (co-) vergisting van mest" and/or "Handreiking monovergisting van mest" are guidelines (no law) which are often used by local governments in the permit procedures for biogas plants. To be able to build a biogas installation a planning permit ("omgevingsvergunning") is needed, which includes permits for spatial planning (zoning), environment, construction, water protection, ammonia emissions etc. Next to the planning permit, the installation needs to be accredited by the Netherlands Food and Consumer Product Safety Authority (NVWA) for the use of animal by-product. Depending on the destination of the digestate (spreading on farm fields verses processing or export) there is strict(er) regulations from the NVWA. Further, (co-) digestion of manure is also part of the manure law ("Meststoffenwet"), which regulates, among other things, which co-substrates can be used in the process.

3.2.7.1. PLANNING PERMIT

To be able to build a biogas installation a planning permit ("omgevingsvergunning") is needed, which includes permits for spatial planning (zoning), environment, construction, waterprotection, nitrogen emissions etc. For most, if not all, small scale biogas installation the municipality is the authority for the permit procedure. For the application of the planning permit, several documents, tests, maps and drawings are to be compiled.

3.2.7.2. ZONING PLAN

Spatial planning is regulated with the zoning plan ("Bestemmingsplan"). It is dependent on the current zoning plan whether a biogas installation can be realised at the location. The first step in planning a farm scale biogas plant is to find out if a biogas installation is allowed in the zone of the company. In the zoning plan is described if, and under what conditions, biogas installations are allowed and, if not, the zoning plan describes what it offers possibilities to aberrate from the prescribed regulations.

As farm-scale biogas plants are mostly build at a farm, the biogas installation will most probably by build in the outlying area of the zoning plan, where the plan offers possibilities for agricultural activities. The key is how "agricultural activities" is defined in the zoning plan and what secondary activities are allowed. Farm-scale installations for digestion, biogas utilization and digestate/manure treatment, which do not import extra manure, are mostly seen as an agricultural activity. Further, be advised that the current zoning plan or the current planning permit may restrict the size of structures and the size of the building block of your company.

When a biogas installation is not allowed, or the size of the installation exceeds the limits of the zoning plan there are two options: 1. the zoning plan already offers the possibility to aberrate for a biogas installation, the procedure is rather straight forward. 2. the zoning plan needs to be individually changed to include a biogas installation, an application to change the plan can take up to 3-4 months. As mentioned the local governments often follow the InfoMil "Handreiking (co-) vergisting van mest" quite strictly when they receive a request to add a biogas installation to the "bestemmingsplan". Before requesting the change it is often helpful to arrange a meeting with the officials who will assess the request. The aberration or change of the zoning plan is part of the planning permit procedure.

3.2.7.3. ENVIRONMENT

For every biogas installation, an environmental permit is part of the planning permit. Depending on the size and lay-out of the installation, the environmental permit can be obtained by fulfilling to a standardized set of requirements set by the government in the activity decree, or by applying for an advanced procedure, where the environmental impact of the installation will be individually assessed and a custom set of regulations and requirements will be designed.

The zoning plan or current planning permit mostly already contains limits and regulations regarding acoustics, odor and emissions in your zone. The authorities can, during the application process, request additional research results for soil

quality, odor, acoustics and air emissions, proving that the installations stays within these boundaries or does not pollute the environment significantly.

Further, be advised that the authorities (municipality or province) may have forbidden the use of certain chemicals in areas of groundwater extraction or groundwater protection areas, or can (and will) add more regulations to the permit.

3.2.7.4. ACTIVITY DECREE

As of July 2015, small scale biogas installations (< 25.000 ton a year, only manure but including biogas upgrading and some techniques of manure treatment) are included in the activities decree ("Activiteitenbesluit"). This means that, as long as you can prove that your installations fulfils the requirements of the activities decree on biogas installations, an environmental permit can be obtained by a limited environmental procedure of 4 weeks.

The following criteria are the most important differences between the limited and the regular procedure[1]:

- Maximum capacity: 25.000 ton manure per year
- Maximum addition of co-substrates: 0 ton per year
- Maximum 430 ppm H_2S is biogas
- At least 50 meters between gas storage and vulnerable objects

Apart from the requirements of the activity decree, the requirements of the zoning plan have to be met.

The activity decree also includes biogas CHP engines up to 2,5 MW_{th}, The mono-nitrogen oxides (NOx) emissions in the exhaust air are however to be accounted for the total nitrogen emissions of the company (see: other regulations of the permit).

3.2.7.5. ADVANCED PROCEDURE

If the installation does not compile with the requirements of the activity decree, the advanced procedure will apply on the application for the environmental permit. This procedure takes up a maximum of 26 weeks, which includes 6 weeks of public availability for inspection by neighbours and other stakeholders. If in this period objections by relevant stakeholders are submitted, the procedure may legally be extended with another 6 weeks. For this procedure no additional costs are demanded by the local authorities. With the advanced procedure the environmental impact of the installation will be individually assessed and a custom set of regulations and requirements will be designed.

3.2.7.6. BUILDING

The building permit is obtained with the regular procedure and takes 4 weeks. The authorities can extend this period with a maximum of 6 weeks. When the building permit is obtained, neighbours and other relevant stakeholders can object to the permit within 6 weeks. The building procedure can be started parallel with the environmental procedure. For the building permit it is advised that the builder of the installation is known, so they can have influence on the building permit application. For the building permit the authorities request building fees, which are a percentage of the total installation costs.

Generally, constructions which deal with manure will need to conform the regulation for manure basins ("Richtlijnen Mestbassins 1992 (RM 1992)") regarding technical requirements on the endurement of the used materials and stability of the construction. Other constructions and structures need to conform the current building code ("bouwbesluit").

[1] Although this enumeration contains the most important criteria, the list is not exclusive. Please consult the activities decree to make sure your installation meets all the criteria for the limited procedure.

3.2.7.7. OTHER REGULATIONS OF THE PERMIT

If the emission of nitrogen of your company deposits on a sensitive nature areas (Natura2000), your company may already have a Nature Conservation permit ("natuurbeschermingswetvergunning"). In this case, for any additional emission of any form of nitrogen, research results will need to be submitted showing that there is no additional deposit on Natura2000 areas, or that the extra deposit has been compensated for. This means that the mono-nitrogen oxides (NOx) in the exhaust air of a biogas boiler or biogas CHP will need to be modelled and accounted for.

In the past it was always necessary to compile an environmental effect assessment report ("M.E.R.") for a biogas installation. Due to a law change this M.E.R. assessment is not requested automatically anymore for biogas installations in the permit application procedure. However, still a form free M.E.R assessment procedure can be requested and, depending on the outcome, authorities may still request to compile a full M.E.R. reporting procedure. If your company is already obliged to the M.E.R. reporting procedure, this will also apply for the biogas installation.

3.2.7.8. MANURE LAW ("MESTSTOFFENWET")

Every company that supplies or produces manure is obliged to keep account of the minerals. If more manure is supplied to and produced at the company than is spread or exported, a mineral levy will be fined. The alleged coproducts are part of these accounts. According to the manure law digestate (fermented manure) from the digester can be spread on farmland under some constraints: only manure is fermented in the digester or, the input of the digester consists of at least 50% manure and less than 50% of products listed in Annex Aa, part IV of the implementation regulation of the Manure Law ("uitvoeringsregeling Meststoffenwet"). In all other cases, the digestate is classified as waste.

3.2.7.9. ACCREDITATION FOR EG 1069/2009

Manure is an animal by-product. Therefore, before you can operate a manure digester, the installation, and all processes connected, has to accredited by the Netherlands Food and Consumer Product Safety Authority (NVWA). The NVWA imposes requirements and regulations on the use of animal by-products in a digester. The aim is to protect public health. Animal by-products are products of animal origin that are not intended for human consumption. There are three categories of animal by-products:

Table 18: Categories of animal by-products as set by the Netherlands Food and Consumer Product Safety Authority (NVWA)

Animal by-products	Definition	Examples of by-products	Elimination route
Category 1	Can seriously endanger public health	Spinal cord, Brains ruminants	Combustion, pressure sterilization, landfill
Category 2	May endanger public health	Manure, residues of veterinary drugs	Combustion, digestion, spreading on agricultural land
Category 3	No serious danger for public health	Kitchen waste, food waste	Feed, digestion, combustion

The export of digestate on the market is regulated by requirements under the EU regulation animal by-products (EG-1069/2009 and EG-142/2011). This means that NVWA also set requirements for the implementation and operation of a digester, if animal by-products are digested.

There are basically three types of accreditation: digestion of Category 2 material, digestion of Category 3 material and digestion of a combination of products from these two categories. The EU Regulation establishes the following requirements for the conversion of animal by-products into biogas:

- Adequate distance between the digester (s) and livestock;
- Strict separation of ingoing manure and digestate to prevent microbiological contamination;
- Facility for cleaning and disinfecting vehicles that deliver manure;
- Facility for cleaning and disinfecting vehicles leaving the plant;
- Adequate storage of fresh manure which is processed as quickly as possible;
- Pest control program present at farm;
- Documenting of the executed hygiene controls;
- Cleaning protocol and cleaning products present at farm;
- Separate digestate storage that guarantees the prevention of recontamination from fresh manure;
- Good process description and diagram present at the installation;
- Pasteurization plants (if applicable; see next page) must be accredited;
- A fully submitted Hazard Analysis and Critical Control Point (HACCP) plan if the processed digestate product is marketed.

Biogas plants that want to market the processed digestate product (e.g. export) or use special materials must in addition to the foregoing requirements, satisfy the requirement of pasteurization or validation. The pasteurisation requirement means that the ingoing manure or digested matter must be heat treated to at least 70°C and the matter should stay at this temperature for at least one hour.

Preferably, each time a new quantity (batch) is heated, such that with certainty all the germs and viruses in the biomass have been killed. However NVWA may also approve a flow system, involving a theoretical residence time (which in term must be approved by the NVWA). The latter can be less energy intensive than pasteurization.

Another option to get accreditation when you want to market your processed digestate is by validation of the process. With validation the digestion process is shown to be equally successful in killing germs and viruses as pasteurization. To get the process validated, samples of the running installation should prove that sufficient germs and viruses are killed during the digestion process (or other process) itself. For validation of the process, sufficient knowledge about the own installation is needed about the retention time (average time biomass remains in the digester), biological processes in the system and monitoring systems.

Be advised to contact the NVWA in an early stage, so that changes in the installation due to regulations van be prevented.

3.3. Emission regulations

3.3.1. Belgium

Flemish emission laws are stated in the VLAREM legislation and can be found on following website: http://navigator.emis.vito.be

3.3.1.1. BIOGAS PLANTS

VLAREM II article 5.31.1.2 regulates the emission values of gas engines either with or without cogeneration.

The values are expressed for dry exhaust gasses in mg/Nm³ and presume an oxygen level of 5% (volume) in the exhaust gasses. (NOx is calculated as NO_2).

Table 19: Emission values for gas engines corresponding to VLAREM II

Type gas engine	Nominal thermical power (MW)	Emission values in mg/Nm³		
		NOx	CO	Organical compound except methane
First permit before 1st January 2000	-	1,300 x 1/30*	1,300	-
First permit on or after 1st January 2000 and before 1st January 2005	-	500 x 1/30	1,300	-
First permit on or after 1st January 2005 and before 1st January 2010	1 >1	500 x 1/30 500	1300 1300	150 150
First permit on or after 1st January 2010	1 1 – 5 5	500 x 1/30 500 250	1,300 1,300 1,300	150 150 150

*1 = nominal motor efficiency

Water emission norms are also regulated by VLAREM legislation. Specific values (see below) for manure processing facilities, which include biogas plants, are given by addendum 5.3.2 24bis of VLAREM II.

Table 20: Water emission norms corresponding to VLAREM

	Chemical oxygen demand (COD)	Biochemical oxygen demand (BOD)	Total nitrogen	Total phosphorus	Chlorides	Total suspended matter
	Parameter in mg/l					
Large businesses (> 60.000 ton/year)	125	25	15	2	1,800	35
Businesses who use calf manure (every size)	125	25	15	2	2,800	35
Other installations	125	25	15	2	-	35

3.3.2. Denmark

Emissions of NOx and CO are regulated in the legal document "Bekendtgørelse om begrænsning af emission af nitrogenoxider og carbon monoxid fra motorer og turbine". According to this document there is no emission limit for biogas fueled engines less than 120 kW. For engines >120 kW and < 5 MW the limit for NOx is 375 mg/Nm^3 CH_4 and for CO the limit is 450 mg/Nm^3 CH_4.

So far there is no specific limit on emission on CH_4. However focus on this is increasing and a regulation is expected to be implemented before too long.

Emissions of NOx, CH_4 and H_2S are subject to environmental tax for plants of more than 1,000 kW input. NOx = 5,3 DKK/GJ, CH_4 = 1,2 DKK/GJ and H_2S = 0,81 DKK/GJ. But from January 1st 2015, biogas is subject to energy tax according to lov nr. 555 (af 2. Juni 2014). The tax is 0,098 DKK/Nm^3 CH_4.

3.3.3. France

The installation of combustion of biogas is submitted to the regulations ICPE on 2910 B or C if the installed thermal power is superior in 100 kW.

Concerning the combustion installation conception, specific arrangements concern the distance minimum in the other constructions (10 m minimum of the limits of property, public access buildings, high-rise buildings, big traffic lanes or zones of storage of fuel). These arrangements can be reduced on the condition of building materials behavior to the fire.

Certain applications planned by the Order (control of emissions, dress of the boiler notebook) can be relieved in the case of small-scale plants.

Emission limit values:

Circular of December 10th, 2003

- For the installations of power lower than 2 MWth no emission limit value is imposed
- For the installations of thermal power between 2 and 20 MWth, we note for boilers the limit values (to 3 % of O_2) of 225 mg / NOx's Nm^3, 50 mg / Nm3 of dusts and 250 mg / CO's Nm^3.

The Order of July 23rd, 2010

- For the installations of thermal power between 20 MWth and 50MW th, we note for boilers the limit values of 200 mg / NOx'sNm^3, 10 mg / Nm^3 dust and 250 mg / CO's Nm^3.

Measures relative to gas flaring have to refer to the article 44 of the order of September 9th, 1997 for the installations of more than 2 MWth. No regulatory measure is imposed for the installations of lower power.

The implementation in French law of the directive n°2010 / 75 / EU of November 24th, 2010 relative to the industrial emissions, in the code of the environment, to the articles L.515-28 and the following ones, establishes the rule of the installation exploited according to " the best available techniques ". However it concerns only the AD plants handling at least 100 tons of waste a day.

3.3.4. Germany

3.3.4.1. EMISSION CONTROL

To protect the environment and the human health, various emissions have to be limited and controlled. Those limitations are defined by the national law and are part of the required conditions to get construction permits. Emission control is regulated in the Federal Imission Control Act [BImSchG 2014] along with the necessary secondary regulations. Here, the Technical Instructions on Air Quality Control and Technical Instruction on Noise Abatement contain the limit values for exhaust gases and noise emitted by the CHP-unit.

Table 21: Limit values exhaust gases for the CHP-unit < 1 MW_{el}

Parameter	Gas engine	Dual fuel engine
Total Dust	-	50 mg/m³
Carbon Monoxide (CO)	1,0 g/m³	2,0 g/m³
Nitrogen Oxides as NO_2	0,5 g/m³	1,5 g/m³
Sulphur Oxide	-	
Organic Substances (Formaldehyde)	-	

Table 22: Noise limit values depending on emission site < 1 MW_{el}

Immission site	Day (6:00 – 22:00 o'clock)	Night (22:00 – 6:00 o'clock)
in industrial areas	70 dB(A)	
in commercial areas	65 dB(A)	50 dB(A)
in central areas, village areas and mixed areas	60 dB(A)	45 dB(A)
in general residential areas and small residential areas	55 dB(A)	40 dB(A)
in residential-only areas	50 dB(A)	35 dB(A)
in spa areas, for hospitals and convalescent / nursing homes	45 dB(A)	35 dB(A)

Gasous emissions of the actual biogas plant as well as substrate and digestate storage areas is summarised in the VDI guideline 3475-4 "Emission control - Agricultural biogas facilities - Digestion of energy crops and manure" [VDI 2010], which describes the current state-of-the art. For small scale biogas plants below 75 kWel installed CHP-power it stipulates for example:

- a GHG emission reduction by providing adequate covering of storage tanks.

  If the biogas plant digests 100% liquid manure (slurry) no special provisions are needed, because of the clear emission reduction through AD.

  Biogas plants that also digest a certain share of energy crops have to cover the storage tank with a gas-tight system. The hydraulic retention time in all tanks that are covered gas-tight has to be 150 days.
- That an alternative gas consumer (e.g. emergency flare or gas boiler) needs to be present at the plant.

Emissions that are hazardous in terms of water pollution are tackled on a national level in the „Federal Water Act" (Wasserhaushaltsgesetz / WHG) and on state level the „Ordinance on installations handling materials hazardous to water" (Verordnung über Anlagen zum Umgang mit wassergefährdenden Stoffen (AwSV)). The state ordinance defines protection levels, e.g. regarding leakage control (tanks and pipelines), catchment and treatment of dirty rainwater and silo juices and prescribes safety measures to protect surface water from contamination with digester slurry and other substances hazardous to water. This concerns for example catchment areas, the construction of silo boxes, etc.

3.3.4.2. WATER PROTECTION

- Biogashandbuch Bayern, Kap. 2.2.4, online available at:
  www.lfu.bayern.de/energie/biogashandbuch/doc/kap224.pdf
- Information sheet „Wasserwirtschaftliche Anforderungen an landwirtschaftliche Biogasanlagen", e.g. available at the Baden-Wurttemberg State Ministry of the Environment, Climate Protection and the Energy: Sector:
  http://um.baden-wuerttemberg.de/de/presse-service/publikation/did/broschuere-wasserwirtschaftliche-anforderungen-an-landwirtschaftliche-biogasanlagen/

3.3.4.3. NOISE AND GAS EMISSION CONTROL

Both ordinances can be downloaded from http://www.gesetze-im-internet.de

VDI-guidelien 3475-4 „Emission control - Agricultural biogas facilities - Digestion of energy crops and manure" can be ordered at: http://www.beuth.de/de/technische-regel/vdi-3475-blatt-4/129221743**Fout! De hyperlinkverwijzing is ongeldig.**

3.3.5. Italy

In Italy a number of regulations exist regarding anaerobic digestions systems and biogas utilization.

Air emissions (engine emissions)

The emissions of the cogenerator of a biogas plant are the most critical environmental aspect of these systems. The people who want to produce renewable energy with biogas should therefore be familiar with the rules and carefully monitor compliance of the plant with all emission parameters. These limits are set-up in the annex – part V of D.Lgs. 152/2006.

The levels are set in mg/Nm^3 and referring to one hour of operation in the harshest conditions, excluding periods of start-up, shutdown, and malfunction. The limits refer to the volume of dry gaseous effluent compared to normal conditions. For internal combustion engines, the emission limit values, referring to a standard volume of oxygen of 5% in the dry flume are the following:

Table 23: Pollution threshold level for engine that use biogas (up to 3 MW thermal power)

Plant thermal power	**3 MW**
Total organic carbon (COT)	150 mg/Nm^3
Carbon monoxide (CO)	800 mg/t Nm^3
Nitrogen oxides (NO_2)	500 mg/Nm^3
Inorganic compounds of Cl (come HCI)	10 mg/Nm3

3.3.6. Poland

In Poland limitations for emissions from energy plants are contained in Regulation of the Minister for the Environment of the 22nd April, 2011 on emission standards of installation (Regulation 95). This document concerns plants where amount of energy introduced to the system fuel is at least 1 MW. Emissions from smaller plants are not regulated.

Additional, in case of need to obtain at least one from the following permits:

- the decision on the environmental conditions on the basis of assessment of environmental impact
- the decision to permit release of gases or dust into the air
- application due to the release of gases or dust into the air,

it has to be checked if level of some emissions in the air do not exceed threshold values presented in Regulation of the Minister for the Environment of the 3rd March, 2008 on the levels of certain substances in the air (Regulation 47). Levels of emission has to be calculated for area of a specified size around the energy plant, defined in Regulation of the Minister for the Environment of the 26th January, 2010 on reference values for some substances in the air (Regulation 16).

Table 24: Overview on emission threshold values for biogas plants (Regulation 95)

Fuel	**Installed power O_2-relative value** (as amount of energy introduced to the system fuel)	**Emission threshold values**						
		Dust	**CO**	**Total C**	**NO_X**	**SO_2**	**HF**	**HCl**
Unit	Vol.-%	mg/Nm³						
Biogas	1 MW 3	5	--	200	35	--	--	--

3.3.7. The Netherlands

Biogas installations

CHP engines used in biogas installations also have to fulfil the regulation of the activities decree, according the numbers below.

Table 25: Emission levels for Boilers with a nominal power > 2.5 MW_{th}

Parameter	NOx	SO_2	Total particulate matter	CxHy
Unit	mg/Nm^3	mg/Nm^3	mg/Nm^3	mg/Nm^3
Biogas	340	200	-	-

If the emission of nitrogen of your company deposits on a sensitive nature areas (Natura2000), your company may already have a Nature Conservation permit ("natuurbeschermingswetvergunning"). In this case, for any additional emission of any form of nitrogen, research results will need to be submitted showing that there is no additional deposit on Natura2000 areas, or that the extra deposit has been compensated for. This means that the mono-nitrogen oxides (NOx) in the exhaust air of a biogas boiler or biogas CHP will need to be modelled and accounted for.

3.4. Subsidy regulations

3.4.1. Belgium

3.4.1.1. INVESTMENT SUBSIDY

Reduced taxable profits: Article 69 of the Code of Income Tax (CIR) allows companies to reduce their taxable profits by an "increased investment deduction" for energy saving investments like micro scale digesters. The deduction shall be made on the profits of the taxable period during which the assets are acquired or established.

For the energy saving investments, made during the taxable period in fiscal year 2014 (investments in 2013), the increased deduction is 14.5%. This is 13.5 % for fiscal year 2015 (investments 2014) [VEA 2014].

A new investment subsidy has started at the beginning of 2015. VLIF (Flemisch agricultural investment funds) will introduce a 30 % subsidy for the supporting infrastructure of the micro scale digester. The list includes:

- Manure mixer
- Manure scraper
- Digestate storage
- Pump and piping system
- Separation waste streams
- Emission reducing manure floor.

There isn't a subsidy for the digester on its own.

The definition of Flemisch agricultural investment funds for farmer is:

- They need a agriculture-number
- Farmer in main occupation, min. 12.0000 euros earned
- Keeping a business economics, tax or corporate accounting
- BBR> 40,000
- Not retired
- Age-up aid to 40 years
- Manager must have 25% of company shares (except LV).

3.4.1.2. CERTIFICATES

Green power certificates are a unique, marketable, electronic and transferable intangible property that shows that a particular production plant produces an amount of renewable energy. One certificate is given for every 1,000 kWh of green electricity that is produced. The value of a certificate is 93 €. The duration of the subsidy is 10 years [VREG 2014].

CHP certificates are given for every 1,000 kWh primary energy saved by using qualitive cogeneration compared to standard installations. This is to promote green heat. You'll get 31 € for each CHP certificate [VREG 2014].

3.4.1.3. OTHER SUPPORT MEASURES (AS FOR 15 OCTOBER 2010):

- Vlaams LandbouwInvesteringsFonds (VLIF) | http://lv.vlaanderen.be/nlapps/docs/default.asp?fid=58
- Vlaams Energieagentschap (VEA) - investment deduction & support for demonstration projects www.energiesparen.be
- De groeipremie | www.vlaanderen.be/groeipremie
- Officiële website van Vlaanderen - advice cheques, starters loan, education support etc. www.vlaanderen.be

3.4.2. Denmark

The subsidy regulations for energy sources based on biogas in Denmark were improved considerably by a governmental agreement on 22nd march 2012 [ENERGIAFTALEN 2012].

The level of support was in general increased, but also equalization between different uses of biogas was implemented, under which the option of distribution of biomethane via the widespread natural gas grid in the country was opened:

Electricity from biogas:

- Basic price 0,79 DKK/kWh
- Additional fee 0,26 DKK/kWh
- Additional fee 0,10 DKK/kWh

The additional fee on 0,10 DKK/kWh will gradually be reduced form 2016.

The additional fee on 0,26 DKK/kWh is adjusted according to variations in the natural gas price.

The basic price of 0,79 DKK/kWh is regulated by 60 % of inflation.

Upgraded biogas injected into the natural gas grid:

- Basic price 79 DKK/GJ
- Additional fee 26 DKK/GJ
- Additional fee 10 DKK/GJ

The additional fee on 10 DKK/GJ will gradually be reduced form 2016.

The additional fee on 0,26 DKK/GJ is adjusted according to variations in the natural gas price.

The basic price of 0,79 DKK/GJ is regulated by 60 % of inflation.

There are also supports for transport and process use of biogas. However, these schemes have not yet been approved by the EU commission.

The surplus heat is exempted from energy tax for utilization.

Danish Energy Agency has elaborated a document with the mentioned price structure and the legal documents behind it. The document can be founder under the below link: www.ens.dk/sites/ens.dk/files/undergrund-forsyning/el-naturgas-varmeforsyning/elforsyning/elproduktion/oversigt_over_stoette_til_elproduktion.pdf

3.4.3. France

In France, the support plan for the biogas sector is based on two complementary administrative levels having for objective to assure the profitability of installations, national level and territorial level.

The subsidies fixed by national level concern the feed-in tariff guaranteed on duration of 15 years:

- For the biogas, the most frequent valorizaion is the heat and electricity production by cogeneration because of the implementation in 2006 of electricic feed-in tariff mechanism according was revised by the Order of May 19th, 2011. It ranges, according to the energy efficiency, the installed electric power and the proportion of used effluents of breeding, between 11,19 and 19,97 centimes of euros / kWh.
- There is since November 23rd, 2011 a feed-in tariff for the biomethane injected in natural gas grid. This price includes a basic rate between 6,4 and 9,5 centimes of euros / kWh according to the size of the installation, to which can be added a bonus calculated according to the nature of the materials treated by AD. This bonus is between 2 and 3 centimes of euros / kWh if inputs consist exclusively of waste or products coming from the agriculture or from the agro-industry. The price ranges from 8,4 to 12,5 centimes of euros / kWh.
- A new plan says "double valorisation" has been set up, who allows the biogas producers to use simultaneously their production in the form of electricity and in the form of biomethane injected in natural gas grid, by granting them the double profit of the existing tariff support for the electricity production from biogas and for the production of injected Biomethane.

The subsidies fixed by territorial level concern investments:

- Territorial aids are granted by the Ministry of environment and energy (ADEME) in conformance with the Fund waste essentially (10 million from euros to 2011 and 18 million euros in 2012 dedicated to the AD in the farm), and in conformance with the Fund heat (for the injection or the valuation of the biogas in the form of heat);
- Investment aids are also granted by local authorities, General Councils and Regional Councils, funds FEDER and FEADER, as well as by the Ministry of Agriculture within the framework of the Farms Energy Performance Plan (28 million euros dedicated to the AD in the farm within the framework of the axis 5 of the EPP over the period 2009-2010).

Investment aids are between 20 and 30 % of capital costs approximately at present, according to the projects and the local conditions.

3.4.4. Germany

For Germany, various subsidy regulations with respect to bioenergy are available on different administrative levels (e.g., national level, federal state level, etc.), for specific kinds of biomass and/or bioenergy (heat, electricity) and for different target groups (e.g., private persons, business companies, etc.). Moreover, subsidies may contain non-repayable investment grants, low-interest loans or fixed tariffs for electricity provision.

Following a short description of main subsidy regulations and the relevant links for amount of subsidy will be given. Please note that the Renewable Energy Sources Act has changed in 2012 and generally amounts and frame conditions of subsidies can change within short time periods.

Table 26: Information about the German Renewable Energy Sources Act [EEG 2014]

Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz (EEG))	
Focus	The Renewable Energy Sources Act came into force in 2000 and was amended in 2004, 2009 and 2012. It was last amended in 2014. It rules: ▪ Priority connection to the grid systems for general electricity supply of installations generating electricity from renewable energy sources and from mine gas within the territory of the Federal Republic of Germany, including its exclusive economic zone, ▪ The priority purchase, transmission, distribution of and payment for such electricity by the grid system operators, and ▪ The nationwide equalisation scheme for the quantity of electricity purchased and paid for. With regard to biomass the Renewable Energy Sources Act refers to electricity provision from biogas, wood and other biomass substrates (for specification of biomass substrates which are applicable within EEG: see "Biomasseverordnung" at www.erneuerbare-energien.de)
Target groups	Operators of plants which provide electricity from renewables (e.g. from biomass) to the electricity grid.
Content	With the EEG 2014 the subsidy scheme has changed drastically for electricity production from renewable energy sources. While in the past feed-in tariffs for constant power production have been the standard, the new subsidy scheme demands direct electricity marketing of 50 % of the produced electricity. For the remaining 50 % the power producer is entitled for financial support. A new terminology "applicable value" (anzulegender Wert) has been created that forms the basis for calculating the amount of money a plant operator receives from the grid operator for feeding the electricity into the grid. Despite the fact that (partial) direct marketing is now mandatory for new biogas plants in Germany, some exceptions are made for plants that can sell all the electricity to the grid and receive a feed-in tariff. One of those exceptions are small biogas plants up to 75 kWel that have at least 80 % manure in their feedstock mix.

Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz (EEG))	
Detailed Amount of subsidy / Links	For those small biogas plants the applicable value is 23,73 ct/kWhel (§ 46 EEG 2014) for all plants built in 2014 and 2015. However, to determine the feed-in-tariff, 0,2 ct/kWhel have to be substracted from the applicable value (§ 37 EEG 2014). The feed-in-tariff is hence 23,53 ct/kWhel. For all biogas plants that will be built after 31 December 2015 the applicable value is subject to a quarterly degression of 0,5 % on 1 January, 1 April, 1 July and 1 October compared to the previous three calendar months. Thus, the applicable financial support / feed-in-tariff depends on the time of plant commissioning. The biogas plant will the receive the feed-in-tariff for 20 years and for the power generated in the year of commissioning. Links and further information: ▪ KTBL Online biogas calculation tool: http://daten.ktbl.de/biogas/startseite.do ▪ German Renewable Energy Sources Act (EEG) 2014: http://www.gesetze-im-internet.de/eeg_2014/ ▪ Extensive information and motivation: www.erneuerbare-energien.de
Comments	This information is of December 2014. For biogas plants larger than 75 kWel the calculation of financial support by the EEG became very complex in the EEG 2014, because of the mandatory direct marketing. Therefore this information on feed-in-tariffs and support schemes is limited to our definition of a small scale biogas plant in Germany. Alternative to the EEG the Act on Combined Heat and Power Generation regulates the feed-in tariffs for power produced by CHP units that are not fuelled with biogas.

On a national level investors can apply for low interest loans. In August 2014 the following programs exist:

- KfW-Program Renewable Energies

  "Standard"Includes biogas plants, up to 100 % of the net investment costs can be financed , accessible via the investor's regular bank, no deadline specified

  https://kfw.de
- KfW-Program Renewable Energies "Premium"

  Valid for periphery of the biogas plant, e.g. installation or expansion of a district heating system or the construction of a micro gas-grid or large heat storage tanks, up to 100 % of the net investment costs can be financed , accessible via the investor's regular bank, no deadline specified

  https://kfw.de
- rentenbank Program "Energie vom Land"

  Includes biogas plants, up to 100 % of the net investment costs can be financed , accessible via the investor's regular bank, run s until 31 December 2014

  www.rentenbank.de
- BAFA support for heating and cooling grids as well as storage

  Level of support depends on the parameters of the heating / cooling network. If average diameter of flow pipe < DN 100: 100 Euro per meter length of the flow pipe, max. 40% of investment costs, but not more than 10 Mio. Euro per project; if average diameter of flow pipe > DN 100: 30% of investment costs, but not more than

10 Mio. Euro per project, no deadline specified | www.bafa.de

A current and comprehensive overview of public funding and grants in Germany e.g. for the use of biomass for energy production purposes supplies the BINE Informationsdienst des Fachinformationszentrums. It lists all relevant federal and federal state funding programs and, where appropriate, funding opportunities offered by municipalities which are accessible for individuals: www.energiefoerderung.info

The following links give an overview on the huge variety of subsidy options for Germany:

- German Business Development Bank:
  www.foerderdatenbank.de
- Fachagentur Nachwachsende Rohstoffe e.V.:
  http://biogas.fnr.de/rahmenbedingungen/foerderungen1/
- Centrales Agrar-Rohstoff Marketing- und Energie-Netzwerk e.V.:
  www.carmen-ev.de/infothek/foerderung

3.4.5. Italy

For Italy, various subsidy regulations with respect to bioenergy are available on different administrative levels (e.g., national level, federal state level, etc.), for specific kinds of biomass and/or bioenergy (heat, electricity) and for different target groups (e.g., private persons, business companies, etc.).

The following links give an overview on the huge variety of subsidy options for Italy:

- Centro Nazionale per la promozione delle Fonti Energetiche Rinnovabili:

  http://www.fonti-rinnovabili.it/index.php?c=nincentivi
- Gestore dei Servizi Energetici:

  http://www.gse.it/en/qualificationandcertificates/CerificatesofOrigin/Pages/default.aspx

Following a short description of main subsidy regulations and the relevant links for amount of subsidy will be given.

3.4.5.1. GREEN CERTIFICATES (GCS)

Green Certificates (GCs) are tradable instruments that GSE grants to qualified renewable-energy power plants (IAFR qualification) which have been commissioned before 31 December 2012 as per Legislative Decree 28/2011.

The number of certificates issued is proportional to the electricity generated by the plant/system and varies depending on the type of renewable source used and of project (new, reactivated, upgraded, renovated system/plant).

The GC support scheme is based on the legislation which requires producers and importers of non-renewable electricity to inject a minimum quota of renewable electricity into the power system every year.

GCs represent proof of compliance with the renewable quota obligation: each GC is conventionally worth 1 MWh of renewable electricity. GCs are valid for three years: those issued in respect of electricity generation in a given year (reference year) may be used towards compliance with the obligation also in the following two years.

To fulfil their obligation, producers and importers may inject renewable electricity into the grid or purchase an equivalent number of GCs from green electricity producers.

3.4.5.2. HOW TO OBTAIN GCS

Producers may apply for GCs after qualifying their plants as renewable-energy power plants/systems (IAFR).

Producers whose plants/systems have a yearly average nominal capacity not exceeding 1 MW (0.2 MW for wind power plants/systems), excluding solar ones, may exercise the right of option between GCs and the all-inclusive feed-in tariff.

Upon the first issuing of GCs, GSE opens an ownership account in the name of the producer, where the issued GCs are deposited. GSE tracks the movements of GCs via a dedicated information system. Holders of ownership accounts may access the system after obtaining an appropriate identification code from GSE.

GSE also creates ownership accounts in the name of producers and/or importers subject to the obligation specified in art. 11 of Legislative Decree 79/99 (upon receiving their self-certification concerning the non-renewable electricity that they have generated and/or imported), as well as in the name of parties wishing to trade GCs.

Holders of ownership accounts may - through the Internet - connect to their dedicated area of the information system in order to immediately check the status of and movements in their accounts and enter GC purchase and/or sale transactions.

The support mechanism

Plants with a capacity of at least 1 kW which are connected to the electricity network are eligible for the GC mechanism. However, plants with a capacity of up to 1 MW (0.2 MW for wind power) may opt for the all-inclusive fixed tariff.

The support mechanism differs according to the technology used.

In fact, Law No 244/2007 introduced a table of multiplication coefficients on the basis of which the number of GCs issued varies according to the renewable source used.

Table 27: Multiplication coefficients of financial law 2009 for GCs

No.	Renewable energy source	Factor
1	Wind power, for plants larger than 200 kW	1,00
1 b	Offshore wind power	1,50
2	Geothermal	0,90
3	Wave and tidal power	1,80
4	Hydro	1,00
5	Biodegradable waste, biomass other than that included in the point below	1,30
6	Biomass and biogas produced by local agriculture or forestry	1,80
7	Landfill gas and residual gases from purification processes and biogas other than those included in the point above	0,80

Average price for certificates

The Energy Markets Regulator (GME), which manages the GC market, publishes all the information on exchanging certificates (quantities and prices) online.

No real floor bottom price has been set for green certificates, since the price is determined by the market, according to the principle of supply and demand.

Nonetheless, the Ministerial Decree of 18/12/2008 established that, in order to prevent an excessive supply, during the three-year period and at the holders' request, the GSE can withdraw the GCs for production referring to years up to 2010. The withdrawal price is the average price over the previous three years for exchanges of all GCs regardless of the reference year, either on the GME-regulated market or through bilateral contracts. The 2010 withdrawal price for GCs is 88.90 €/MWh.

There is also a reference price, which is the price at which the GSE puts GCs onto the market (the regulations allow for this possibility in order to deal with demand which exceeds supply) which, per MWh of electricity, is equal to 180 € minus the annual average electricity transfer price for the previous year (defined by the AEEG). The GC reference price set by the GSE for 2010 is 113.8 €/MWh.

In the event of excessive supply, where the price paid by the GSE to withdraw GCs is lower than the GSE's selling price, it is probable that a GC market will develop between a minimum price, equal to the price paid by the GSE to withdraw GCs, and a maximum price equal to the GSE's selling price.

3.4.5.3. CERTIFICATION OF GENERATED/ IMPORTED ELECTRICITY

On a yearly basis, GSE verifies compliance with the obligation specified in article 11 of Legislative Decree 79/99 (quota obligation).

Obliged parties

By 31 March of each year (n), producers and importers of conventional electricity that are subject to the obligation (electricity > 100 GWh) must submit a self-certification of the data that are required to determine:

i) the electricity subject to the obligation in respect of generation and/or imports in the previous year (n-1)

ii) the green certificates (GCs) corresponding to the yearly mandatory quota in respect of generation in the year (n-2).

The renewable electricity to be injected into the power system in compliance with the above mentioned obligation must be generated by RES-E (IAFR) qualified plants.

Exemptions from the obligation are as follows:

- renewable electricity generated in CHP (co-generation) plants
- renewable electricity imported for the reference year 2011, provided that it is certified by Guarantees of Origin issued by an EU Member State or Norway or Switzerland, in accordance with art. 15 of Directive 2009/28/EC
- renewable electricity which may count towards the achievement of the national target of 17%, under art. 25, para. 2 of Legislative Decree 28/2011.

GSE's role

If producers or importers fail to fulfil their obligation or to submit their data (self-certification), GSE will - under the Ministerial Decree of 24 October 2005 - report them to AEEG, which will impose the penalties specified in art. 4, paragraph 3 of Legislative Decree 387/03.

The number of GCs to be introduced into the national power system is obtained by multiplying the amount of the generated and/or imported electricity, subject to the obligation and exceeding 100 GWh, by the mandatory quota for the reference year.

Table 28: Mandatory quota system for GCs to be introduced into the national power system

Reference year	Mandatory quota (%)	Compliance year
2007	3.80	2011
2008	4.55	2012
2009	5.30	2013
2010	6.05	2014
2011	6.80	2015
2012	7.75	2016
From 2013 onwards as provided by Dlg 28/2011, the quota obligation is reduced equal to zero in 2015.		

3.4.5.4. ALL-INCLUSIVE FEED-IN TARIFF

The all-inclusive feed-in tariff (tariffa onnicomprensiva) is a national scheme applicable to RES-E plants (excluding solar ones) which have a nominal real power of less than 1 MW (200 MW for on-shore wind plants).

The tariff is granted over a period of 15 years, during which its rate remains fixed and based on the amount of electricity fed into the grid, for all plants commissioned by 31 December 2012.

To benefit from this form of support, producers must first ask GSE to qualify their plants as RES-E ("IAFR – Impianto Alimentato a Fonti Rinnovabili").

It represents an alternative to the green certificates scheme and is differentiated by type of source.

Table 29: Feed-in rates for renewable energy sources in Italy

Renewable energy source	All-inclusive feed-in rate in €cent/kWh
Wind (P < 200 kW)	30
Geothermal	20
Waves and tides	34
Hydro (other than the one indicated in the previous point)	22
Biomass, biogases and bioliquids complying with Regulation (EC) No 73/2009	28
Landfill gas, sewage treatment plant gas, biogases and bioliquids complying with Regulation (EC) No 73/2009	18

For the plants commissioned after 31 December 2012 the feed-in tariff is garanted over a period of 20 years and there are different tariff for varying classes of generated power.

Table 30: Subsidies in Italy for electric generation from biogas in place as of January 1st, 2013*

Electric power generated	1 < P ≤ 300 kW_{el}		300 < P ≤ 600 kW_{el}		600 < P ≤ 1,000 kW_{el}	
	all	biomass	all	biomass	all	biomass
Feed mix	≤30% crop biomass	>30% crop biomass	≤30% crop biomass	>30% crops	≤30% crop biomass	>30% crops
	>70 % by-products	<70 % by-products	>70 % by-products	<70 % by-products	>70 % by-products	<70 % by-products
Incentives (€/MWh)						
Base incentive	231	176	204	157	174	137
Efficient Cogeneration	10	40	10	40	10	40
Heating network	30	N/A	30	N/A	30	N/A
Nitrogen separation	30	30	30	30	30	30
Maximum Contribution	301	246	274	227	234	207

* The base incentive, depending on feed mix and generated power, can be increased by efficient cogeneration, heating network, and nitrogen separation.

The right of option between green certificates and the all-inclusive tariff is exercised upon submitting the application for RES-E ("IAFR") qualification to GSE. Before the end of the support period, a single passage is allowed from one support scheme to the other; in this case, the duration of the period of eligibility for the new support scheme is reduced by the period of eligibility that has already elapsed under the previous scheme.

3.4.5.5. HIGH-EFFICIENCY CHP AND WHITE CERTIFICATES

Combined heat & power generation (CHP) or co-generation provides significant energy savings compared to separate generation. The criteria for qualifying generating units as high-efficiency CHP are set out in the Ministerial Decree of 4 Aug. 2011, effective from 1st Jan. 2011. This decree completed the transposition of Directive 2004/8/EC, started with Legislative Decree no. 20 of 2007, into the Italian legislation. Generating units qualified as high-efficiency CHP have access to the Energy Efficiency Certificates ("TEE" or white certificates) scheme, on the terms and conditions and under the procedures specified in the Ministerial Decree of 5th Sept. 2011.

GSE carries out the following activities:

- qualifying high-efficiency CHP plants
- determining the number of white certificates to be issued to high-efficiency CHP
- qualified units whose owners have applied for this form of support
- buying back white certificates - in response to a request made by a producer - at a price equal to the one applicable on the date of commissioning of the unit (or on the date of entry into force of the Ministerial Decree of 5th Sept. 2011 in the case of units already in operation)
- carrying out activities of verification and monitoring of the supported plants and notifying the Ministry of Economic Development and the producer of their outcome
- issuing the Guarantee of Origin of electricity from high-efficiency co-generation (CHP-GO) in compliance with Legislative Decree no. 20 of 2007.

3.4.5.6. GUARANTEE OF ORIGIN (GO)

The Guarantee of Origin (GO) is a voluntary certificate giving evidence of electricity generation from renewables and issued on demand to producers. In Italy, the GO was introduced by Legislative Decree 387/03, implementing Directive 2001/77/EC on promotion of electricity produced from renewable energy sources in the internal electricity market. With the GO, producers may demonstrate the origin of the electricity that they sell. Legislative Decree 28/11, transposing Directive 2009/28/EC, repealed Directive 2001/77/EC and introduced some new provisions concerning the GO.

The new GO (art. 34, Legislative Decree 28/11) has the sole purpose of enabling electricity suppliers to disclose the share of renewable energy in their fuel mix to final customers. The new GO will be issued, transferred and cancelled electronically. An implementing decree will update the procedures regarding the issuing and utilisation of the new GO.

GSE's role

Prior to issuing the Guarantee of Origin (GO), GSE is required to conduct a procedure of technical identification of plants, as specified in the Decree of the Ministry of Productive Activities of 24 Oct. 2005 (updated guidelines on support for electricity generated from renewables as per art. 11, para. 5, Legislative Decree no. 79 of 16th March 1999). To this end, GSE developed a specific Technical Procedure. Under article 11, para. 1 of the above-mentioned decree, the procedure was approved by the Ministry of Economic Development, in consultation with the Ministry of Environment, Land and Sea Protection, with its Decree of 21st Dec. 2007 (Gazzetta Ufficiale no. 16 of 19 Jan. 2008, Supplemento Ordinario no.17).

After obtaining the technical identification ("IRGO") of their plants, operators may - on a yearly basis - ask GSE to issue the GO for their generated electricity. To submit the application for technical identification of plants ("IRGO") and obtain the GO, fill in the application forms in the format shown in the "Documents" section on the right side of this page (italian version).

3.4.5.7. RENEWABLE-ENERGY CERTIFICATES OF ORIGIN (RECOS)

A Renewable Energy Certificate of Origin ("CO-FER" - RECO) gives proof of the renewable origin of the sources used by power plants which have been qualified to obtain Certificates of Origin ("ICO-FER" qualification).

Each RECO is worth 1 MWh and issued on the basis of the electricity fed into the grid by the above- mentioned plants. RECOs may be transferred from producers to suppliers, also through traders.

GSE's role

GSE grants the ICO-FER qualification at the request of producers. The qualification document specifies the renewable electricity generated by each plant. GSE issues RECOs - at the request of producers whose plants are ICO-FER qualified - on a monthly basis. The number of RECOs is based on the meter readings of the electricity fed into the grid that GSE receives from grid operators.

In order to obtain the ICO-FER qualification, producers must meet the requirements of the "Procedura per l'identificazione degli impianti alimentati da fonti rinnovabili ed emissione e gestione delle certificazioni di origine per i suddetti impianti" (procedure for identifying renewable energy plants in view of issuing and managing Certificates of Origin) – see Italian version.

The procedure makes it possible to:

- identify the producer and the type of renewable energy source used to generate the electricity to be certified
- certify the electricity generated by renewable-energy plants and injected into the grid by each producer
- transfer RECOs (that GSE has issued to the producer) to selling companies under principles of transparency and traceability, so that each RECO is at all times owned by a single party.

3.4.6. Poland

In Poland investments in bioenergy plants can be financed from e.g.:

- Preferential environmentally friendly loans with subsidies to interest paid or to some extent redemption of loan possible from:
  - National Fund for Environmental Protection and Water Management in cooperation with banks
  - Provincial Funds for Environmental Protection and Water Management in cooperation with banks
- Subsidy in the form of non-returnable aid getting during competitions taking place in different dates to the end of 2013. Subsidy can be getting:
  - in the Operational Programme Infrastructure and Environment – OPI&E (usually the minimal value of the project is PLN 10 mln, the subsidy is in the form of a prepayment or refundation)
  - in the Regional Operational Programmes of particular voivodeship - ROP (usually the maximal value of the project is PLN 10 mln, the subsidy is in the form of a prepayment or refundation)
  - in the Rural Development Programme, for places with max 5,000 inhabitants - RDP (the subsidy is in the form of refundation).

Table 31: Overview of fund for environmental protection and water management in Poland

The National Fund for Environmental Protection and Water Management (NFOSiGW)	
Focus	▪ Co-financing mainly large investments with the nationwide and supra-regional significance which e.g. eliminate pollution of air ▪ Investments connected with improving energy efficiency and using renewable energy sources are treated as special priorities
Target groups	Entities undertaking projects of the enterprises in the field of renewable energy sources and high-efficiency cogeneration
Content/ How regulation works	Several sub-programmes exist which offer different low-interest loans and subsidies to interest paid or to some extent redemption of loans.
Amount of subsidy / links	Low-interest loans and possibilities of getting subsidies to interest paid or to some extent redemption of loans are listed under: Overview and loans: www.nfosigw.gov.pl/srodki-krajowe/programy-priorytetowe/oze-i-kogeneracja/ Subsidies to interest paid: www.nfosigw.gov.pl/srodki-krajowe/doplaty-do-kredytow/doplaty-do- oprocentowania-kredytow/ Redemption of loans: www.nfosigw.gov.pl/srodki-krajowe/umorzenia/
Comments	Low-interest loans and possibilities of getting subsidies to interest paid or to some extent redemption of loans are modified regularly!

Table 32: Overview of provincial funds for environmental protection and water management in Poland

Provincial Funds for Environmental Protection and Water Management (WFOSiGW)	
Focus	▪ Co-financing investments which e.g. eliminate pollution of air ▪ Investments connected with improving energy efficiency and using renewable energy sources are treated as special priorities
Target groups	Entities undertaking projects of the enterprises in the field of renewable energy sources and high-efficiency cogeneration
Content/ How regulation works	▪ Several sub-programmes exist which offer different grants and subsidies to interest paid (in cooperation with defined banks) or to some extent redemption of loans ▪ Programmes are concerned individual voivodeships.
Amount of subsidy / links	Grants and possibilities of getting subsidies to interest paid or to some extent redemption of loans are listed under, for example of Warsaw Fund for Environmental Protection and Water Management (every voivodeship has its own rules of co-financing investments): Grants: www.wfosigw.pl/strefa-beneficjenta/zasady-dofinansowania/zasady- dofinansowania Subsidies to interest paid (in coopoeration with BOS S.A., Cooperative Bank in Mszczonów, Bank PKO B.P.): www.wfosigw.pl/strefa-beneficjenta/doplaty_do_kredytow/Regulamin Redemption of loans: www.wfosigw.pl/strefa-beneficjenta/umorzenia
Comments	Grants and possibilities of getting subsidies to interest paid or to some extent redemption of loans are modified regularly!

Following a short description of main subsidy regulations and the relevant links for amount of subsidy will be given (main link is www.funduszeeuropejskie.gov.pl/). Please note that it will be valid to 2013.

Types of aid mentioned above are presented in the table below, where are specified: types of projects for aiding (financing of investment in wood combustion, biogas plants contains also investment in biogas plant, if it occurs in project), total investment cost and possible financing of eligible costs (every programme defines percentage of subsidy to eligible costs, sometimes also minimal and maximal values; to simplify the assumption was made in the table – total investment cost is equal to eligible costs), types of beneficiary (in many cases all entitled to subsidy are not enumerating, there '…' is written).

Table 33: Overview of operational programme infrastructure and environment

The operational programme infrastructure and environment (POIiS)	
Measure 4.5. Support for enterprises for air protection	
Focus	▪ Conversion of existing conventional combustion installations into biomass/biogas plant (excluding projects, as a result of which emission to the air will increase) ▪ Total cost of investment has to be at least PLN 8 mln for small[2] and medium-sized[3] enterprises; for large[4] enterprises total cost of investment is not defined
Target groups	Entrepreneurs
Amount of subsidy / links	▪ Up to 30% of the total investment cost ▪ Up to PLN 20 mln ▪ Overview: http://www.funduszeeuropejskie.gov.pl/PoradnikBeneficjenta/Polis/Strony/4.5-Wsparcie-dla-przedsiebiorstw-w-zakresie-ochro.aspx
Measure 9.1. High-efficiency energy generation	
Focus	▪ Construction and reconstruction of heat and power cogeneration plants or heat generation plants, as a result of which these plants will satisfy the requirements laid down for high-efficiency cogeneration[5] (excluding fossil fuel co-combustion plant) ▪ Total cost of investment has to be at least PLN 10 mln for units using biomass/ biogas and at least PLN 20 mln for the rest
Target groups	▪ Entrepreneurs ▪ Territorial self-government units and their groups ▪ Public service obligations as part of their territorial self- government units

2 Small enterprise – enterprise which employs fewer than 50 employees and whose annual turnover does not exceed EUR 10 mln

3 Medium-sized enterprise – enterprise which employs fewer than 250 employees and whose annual turnover does not exceed EUR 50 mln

4 Large enterprise – enterprise which employs min. 250 employees or whose annual turnover exceed EUR 50 mln

5 High-efficiency cogeneration – coproduction of heat and electric energy providing primary energy saving (PES) in comparison with separated production (for plant of electric power at least 1 MW saving has to attain min. 10%).

The operational programme infrastructure and environment (POIiS)	
Amount of subsidy / links	▪ Up to 65% of the total investment cost for small enterprises[2] ▪ Up to 55% for medium-sized enterprises[3] ▪ Up to 45% for large enterprises4 ▪ Up to PLN 30 mln ▪ Overview: http://www.funduszeeuropejskie.gov.pl/PoradnikBeneficjenta/Polis/Strony/9.1-Wysokosprawne-wytwarzanie-energii.aspx
Comments	Primary energy saving (PES) is calculated using this formula: $$PES = \left[1 - \frac{1}{\frac{\eta_{qc}}{\eta_{refc}} + \frac{\eta_{qe}}{\eta_{refe}}}\right] \cdot 100$$ η_{qc}: efficiency of heat production in cogeneration η_{qe}: efficiency of electricity production in cogeneration η_{refc}: reference efficiency of heat production in separate generation – adequately if heat is taking by process steam/hot heating water or exhaust gases are used directly: for agricultural biomass – 80%/72%, for biogas – 70%/62% η_{refe}: reference efficiency of electricity production in separate generation – if plant were put into operation in 2006-2011:for agricultural biomass – 25%, for biogas – 42%
Measure 9.4. Generation of energy from renewable sources	
Focus	▪ Construction or power increasing of plant using biomass/biogas, cogeneration is not required ▪ Total cost of investment has to be at least PLN 10 mln for units using biomass/ biogas and at least PLN 20 mln for the rest
Target groups	E.g. entrepreneurs, territorial self-government units and their groups, public service obligations as part of their territorial self- government units, …

The operational programme infrastructure and environment (POIiS)	
Amount of subsidy / links	▪ Up to 65% of the total investment cost for small enterprises[2] ▪ Up to 55% for medium-sized enterprises[3] ▪ Up to 45% for large enterprises[4] ▪ Up to PLN 40 mln ▪ Overview: www.funduszeeuropejskie.gov.pl/PoradnikBeneficjenta/Polis/Strony/9.4-Wytwarzanie-energii-ze-zrodel-odnawialnych.aspx
Measure 9.5. Production of biofuels from renewable sources	
Focus	▪ Construction of biogas production installation ▪ Total cost of investment has to be at least PLN 20 mln
Target groups	Entrepreneurs
Amount of subsidy / links	▪ Up to 50% of the total investment cost for voivodeships: Lubelskie, Podkarpackie, Warminsko-Mazurskie, Podlaskie, Switokrzyskie, Opolskie, Malopolskie, Lubuskie, tódzkie, Kujawsko-Pomorskie ▪ Up to 40% for voivodeships: Pomorskie, Zachodniopomorskie, Dolnoslq_skie, Wielkopolskie, Slq_skie ▪ Up to 30% for the Mazowieckie voivodeship ▪ For micro-[6] and small[2] enterprises subsidy may be increased by 20 p.p. ▪ For medium-sized[3] enterprises subsidy may be increased by 10 p.p. ▪ Up to PLN 30 mln ▪ Overview: www.funduszeeuropejskie.gov.pl/PoradnikBeneficjenta/Polis/Strony/9.5-Wytwarzanie-biopaliw-ze-zrodel-odnawialnych.aspx
Comments	Subsidies are modified regularly!

6 Microenterprise – enterprise which employs fewer than 10 employees and whose annual turnover does not exceed EUR 2 mln

Table 34: Overview of regional operational programmes

Regional operational programmes (PR)	
Only for the Dolnoslqskie voivode ship – Measure 5.1. Renewable energy sources	
Focus	▪ Construction or reconstruction biogas production installation and plant using biomass/biogas ▪ Total cost of investment has to be at least PLN 300,000 in places not falling under RDP[7], min. PLN 3 mln in places falling under RDP for communities or organizational units with organizer as a territorial self-government unit and up to PLN 10 mln
Target groups	E.g. energy companies, public sector entities, unions and associations of territorial self-government units, …
Amount of subsidy / links	▪ For investments falling under the public aid[8]: up to 60% of the total investment cost for micro-[6] and small[2] enterprises, up to 50% for medium-sized[3] enterprises, up to 40% for the rest ▪ Up to 99% for territorial self-government units ▪ Overview: http://rpo.dolnyslask.pl/index.php?id=1112
Only for the Kujawsko-Pomorskie voivodeship - Measure 2.4. Environment-friendly energy infrastructure	
Focus	▪ Construction or reconstruction biogas production installation and plant using biomass/biogas ▪ Total cost of investment can be up to PLN 10 mln for units using biomass/biogas and up to PLN 20 mln for the rest
Target groups	E.g. companies established and operating in the voivodeship kujawsko-pomorskie, unions and associations of territorial self-government units,…
Amount of subsidy / links	▪ For investments not falling under the public aid[8]: up to 75% of the total investment cost ▪ For investments falling under the public aid[8]: up to 70% for microenterprises[6], up to 60% ▪ For small[6] and medium-sized[3] enterprises, up to 50% for the rest up to 100% for budget units ▪ Overview:

7 PR of particular voivode ships defines range of subsidy to investments leading by a community or organizational unit with organizer as a territorial self-government unit, in places falling under RDP: min. PLN 3 mln, whereas if the community cannot use the subsidy from RDP it is max PLN 3 mln

8 falling under the public aid - when the investor leads economic activity, also non-profit

Regional operational programmes (PR)	
	http://www.mojregion.eu/opis-dzialania/rpo-2.4.html
Only for the Lubelskie voivodeship – Measure 1.4. Investment subsidy to adaptation of enterprises to environmental protection requirements and to renewable energy sources	
Focus	▪ Construction or reconstruction biomass/biogas plants ▪ Total cost of investment can be at least PLN 15,000 and up to PLN 8 mln for projects, in which electric energy is used for internal load ▪ Total cost of investment can be at least PLN 143,000 and up to PLN 10 mln for projects, in which maximum 50% of electric energy is used for internal load
Target groups	Micro-, small and medium-sized entrepreneurs
Amount of subsidy / links	▪ For projects, in which electric energy is used for internal load: up to 70% of the total investment cost ▪ For projects, in which maximum 50% of electric energy is used for internal load: up to 70% of the total investment cost for micro-[6] and small[2] enterprises and up to 60% for medium-sized[3] enterprises ▪ Overview: http://www.rpo.lubelskie.pl/widget/file/get/1327570587392676.pdf/Szczeg%25C3%25B3%25C5%25820wy%2BOpis%2BOsi%2BPriorytetowych/Szczeg%25C3%25B3%25C5%25820wy%2BOpis%2BOsi%2BPriorytetowych.pdf
Only for the Lubelskie voivodeship – Measure 6.2. Environment-friendly energy	
Focus	▪ Construction or reconstruction biogas production installation and plant using biomass/biogas ▪ Total cost of investment can be up to PLN 10 mln for units using biomass/biogas and up to PLN 20 mln for the rest
Target groups	E.g. territorial self-government units, …
Amount of subsidy / links	▪ Up to 100% of the total investment cost for territorial self-government units ▪ Overview: http://www.rpo.lubelskie.pl/widget/file/get/1327570587392676.pdf/Szczeg%25C3%25B3%25C5%25820wy%2BOpis%2BOsi%2BPriorytetowych/Szczeg%25C3%25B3%25C5%25820wy%2BOpis%2BOsi%2BPriorytetowych.pdf

Regional operational programmes (PR)	
Only for the Lubuskie voivodeship – Measure 3.2. Improvement of air quality, energy efficiency and development and renewable energy sources utilization	
Focus	▪ Construction or reconstruction biogas production installation and plant using biomass/biogas ▪ Total cost of investment can be up to PLN 10 mln for units using biomass/biogas and up to PLN 20 mln for the rest
Target groups	E.g. entrepreneurs, territorial self-government units, …
Amount of subsidy / links	▪ For investments not falling under the public aid[8]: up to 85% of the total investment cost ▪ For investments falling under the public aid[8]: up to 70% for micro-[6] and small[2] enterprises, up to 60% for medium-sized[3] enterprises, up to 50% for the rest ▪ Overview: http://www.lrpo.lubuskie.pl/index.php?option=com_content&view=article&id=66&Itemid=150
Only for the Lódzkie voivodeship – Measure II.9. Renewable energy sources	
Focus	▪ Construction or reconstruction biogas production installation and plant using biomass/biogas ▪ Total cost of investment can be up to PLN 10 mln for units using biomass/biogas and up to PLN 20 mln for the rest
Target groups	E.g. entrepreneurs, territorial self-government units, …
Amount of subsidy / links	▪ For investments not falling under the public aid[8]: up to 85% of the total investment cost ▪ For investments falling under the public aid[8]: up to 70% for micro-[2] and small[3] enterprises, up to 60% for medium-sized4 enterprises, up to 50% for the rest ▪ Overview: http://www.rpo.lodzkie.pl/wps/wcm/connect/91a36a8049dc414585528fa5b641bc9c/U_RPO_WL_16012012.pdf?MOD=AJPERES
Only for the Ma1opolskie voivodeship – Measure 7.2. Improvement of air quality and increase of renewable energy sources utilization	
Focus	▪ Construction or reconstruction biogas production installation and plant using biomass/biogas ▪ Total cost of investment can be up to PLN 10 mln for units using biomass/biogas and up to PLN 20 mln for the rest

Regional operational programmes (PR)	
Target groups	E.g. entrepreneurs, territorial self-government units, …
Amount of subsidy / links	▪ For investments not falling under the public aid[8]: up to 85% of the total investment cost ▪ For investments falling under the public aid[8]: up to 70% for micro-[6] and small[2] enterprises, up to 60% for medium-sized[3] enterprises, up to 50% for the rest ▪ Up to 100% for budget units min. PLN 20,000 up to PLN 5 mln ▪ Overview: http://fundusze.malopolska.pl/mrpo/Documents/dokumenty-programowe/uszczegolowienie/15-12-2011-UMRPO.pdf
Only for the Mazowieckie voivodeship – Measure 4.3. Air protection, power engineering	
Focus	▪ Construction or reconstruction biogas production installation and plant using biomass/biogas (up to 10 MW) ▪ Total cost of investment can be up to PLN 10 mln for units using biomass/biogas and up to PLN 20 mln for the rest
Target groups	E.g. entrepreneurs, territorial self-government units, …
Amount of subsidy / links	▪ For investments not falling under the public aid[8]: up to 60% of the total investment cost ▪ For investments falling under the public aid[8]: up to 50% for micro-[6] and small[2] enterprises, up to 40% for medium-sized[3] enterprises, up to 30% for the rest ▪ up to 97% for territorial self-government units ▪ Overview: http://rpo.mazowia.eu/wybierz-priorytet-i-dzialanie/70.html
Only for the Opolskie voivodeship – Measure 4.3. Air protection, renewable energy sources	
Focus	▪ Construction or reconstruction biogas production installation and plant using biomass/biogas ▪ Total cost of investment can be up to PLN 10 mln for units using biomass/biogas and up to PLN 20 mln for the rest
Target groups	E.g. territorial self-government units, …

Regional operational programmes (PR)	
Amount of subsidy / links	▪ For investments not falling under the public aid8: up to 85% of the total investment cost ▪ For investments falling under the public aid[8]: up to 70% for micro-[6] and small[2] enterprises, up to 60% for medium-sized[3] enterprises, up to 50% for the rest ▪ Up to 100% for budget units min. PLN 250,000 up to PLN 5 mln ▪ Overview: http://rpo.opolskie.pl/docs/uszczegolowienie_wersja_no8.pdf
Only for the Podkarpackie voivodeship – Measure 2.2. Energy infrastructure	
Focus	▪ Construction or reconstruction biogas production installation and plant using biomass/biogas ▪ Total cost of investment can be up to PLN 10 mln for units using biomass/biogas and up to PLN 20 mln for the rest
Target groups	E.g. entrepreneurs, territorial self-government units, …
Amount of subsidy / links	▪ For investments not falling under the public aid[8]: up to 75% of the total investment cost ▪ For investments falling under the public aid[8]: up to 70% for micro-[6] and small[2] enterprises, up to 60% for medium-sized[3] enterprises, up to 50% for the rest ▪ Up to 95% for territorial self-government units ▪ Overview: http://www.wrota.podkarpackie.pl/res/rpo/Wazne_dok/uszczeg_opis/urpo_wp_11.10.2011_tj.pdf
Only for the Podlaskie voivodeship – Measure 5.1./2. Development of regional/local environment protection infrastructure	
Focus	▪ Construction or reconstruction biogas production installation and plant using biomass/biogas ▪ Total cost of investment can be up to PLN 10 mln for units using biomass/biogas and up to PLN 20 mln for the rest
Target groups	E.g. entrepreneurs, territorial self-government units, …
Amount of subsidy / links	▪ For investments not falling under the public aid8: up to 85% of the total investment cost ▪ For investments falling under the public aid[8]: up to 70% for micro-[6] and small[2] enterprises, up to 60% for medium-sized[3] enterprises, up to 50% for the rest ▪ Overview: http://www.rpowp.wrotapodlasia.pl/dokumenty/dokumenty-programowe.html

Regional operational programmes (PR)	
Only for the Pomorskie voivodeship – Measure 5.4. Development of power engineering based on renewable sources	
Focus	▪ Construction or reconstruction biogas production installation and plant using biomass/biogas ▪ Total cost of investment can be up to PLN 10 mln for units using biomass/biogas and up to PLN 20 mln for the rest
Target groups	E.g. territorial self-government units, …
Amount of subsidy / links	▪ For investments not falling under the public aid[8]: up to 95% of the total investment cost ▪ For investments falling under the public aid[8]: up to 60% for micro-[6] and small[2] enterprises, up to 50% for medium-sized[3] enterprises, up to 40% for the rest ▪ Overview: http://dpr.pomorskie.eu/res/dpr/dokumenty/urpo/urpo_20_12_2011/urpo_20 12 11.pdf
Only for the Ictskie voivodeship – Measure 5.3. Clean air and renewable energy sources	
Focus	▪ Construction or reconstruction biogas production installation and plant using biomass/biogas ▪ Total cost of investment can be up to PLN 10 mln for units using biomass/biogas and up to PLN 20 mln for the rest
Target groups	E.g. entrepreneurs, territorial self-government units, …
Amount of subsidy / links	▪ For investments not falling under the public aid[8]: up to 85% of the total investment cost ▪ For investments falling under the public aid[8]: up to 60% for micro-[6] and small[2] enterprises, up to 50% for medium-sized[3] enterprises, up to 40% for the rest ▪ Overview: http://rpo.slaskie.pl/zalaczniki/2011/12/14/1323865712.pdf
Only for the Switokrzyskie voivodeship – Measure 4.1. Development of regional environment protection and energy infrastructure	
Focus	▪ Construction or reconstruction biogas production installation and plant using biomass/biogas ▪ Total cost of investment can be up to PLN 10 mln for units using biomass/biogas and up to PLN 20 mln for the rest

Regional operational programmes (PR)	
Target groups	E.g. entrepreneurs, territorial self-government units, …
Amount of subsidy / links	▪ For investments not falling under the public aid[8]: up to 85% of the total investment cost ▪ For investments falling under the public aid[8]: up to 70% for micro-[6] and small[2] enterprises, up to 60% for medium-sized[3] enterprises, up to 50% for the rest ▪ Up to 100% for budget units ▪ Overview: http://rpo.slaskie.pl/zalaczniki/2011/12/14/1323865712.pdf
Only for the Warminsko-Mazurskie voivodeship – Measure 6.2.1. Utilization of renewable energy sources	
Focus	▪ Construction or reconstruction biogas production installation and plant using biomass/biogas (excluding projects, in which electric energy is used for internal load) ▪ Total cost of investment can be up to PLN 10 mln for units using biomass/biogas and up to PLN 20 mln for the rest
Target groups	E.g. entrepreneurs, territorial self-government units, …
Amount of subsidy / links	▪ For investments not falling under the public aid[8]: up to 80% of the total investment cost ▪ For investments falling under the public aid[8]: up to 70% for micro-[6] and small[2] enterprises, up to 60% for medium-sized[3] enterprises, up to 50% for the rest ▪ Overview: http://www.rpo.warmia.mazury.pl/index.php?page=dzial&dzial_id=98
Only for the Wielkopolskie voivodeship – Measure 3.7. Increase of renewable energy resources utilization	
Focus	▪ Construction or reconstruction biogas production installation and plant using biomass/biogas of power range 0.25-50 MW ▪ Total cost of investment can be up to PLN 10 mln for units using biomass/biogas and up to PLN 20 mln for the rest
Target groups	E.g. entrepreneurs, territorial self-government units, …

Regional operational programmes (PR)	
Amount of subsidy / links	▪ For investments not falling under the public aid[8]: up to 85% of the total investment cost ▪ For investments falling under the public aid[8]: up to 60% for micro-[6] and small[2] enterprises, up to 50% for medium-sized[3] enterprises, up to 40% for the rest ▪ Overview: www.wrpo.wielkopolskie.pl/index.php/dokumenty/wrpodokumenty181/uszczegolowienie-wrpo-wersja-7-4
Only for the Zachodniopomorskie voivodeship – Measure 4.1. Renewable energy and power management	
Focus	▪ Construction or reconstruction biogas production installation and plant using biomass/biogas ▪ Total cost of investment can be up to PLN 10 mln for units using biomass/biogas and up to PLN 20 mln for the rest
Target groups	E.g. entrepreneurs, territorial self-government units, …
Amount of subsidy / links	▪ For investments not falling under the public aid[8]: up to 75% of the total investment cost ▪ For investments falling under the public aid[8]: up to 60% for micro-[6] and small[2] enterprises, up to 50% for medium-sized[3] enterprises, up to 40% for the rest ▪ Overview: http://www.rpo.wzp.pl/rpo/uszczegolowienie_rpo/p-r-m-a-14684/uszczegolowienie_rpo.htm
Comments	Subsidies are modified regularly!

Table 35: Overview of rural development programme in Poland

Rural Development Programme	
Measure 311. Diversification into non-agricultural activities	
Focus	Construction or reconstruction biogas production installation and plant using biomass/biogas (excluding places with more than 5,000 inhabitants)
Target groups	Natural person (farmer)
Amount of subsidy / links	▪ Up to 50% of the total investment cost up to PLN 100,000 ▪ Overview: http://prow.rolnicy.com/roznicowanie-w-kierunku-dzialalnosci-nierolniczej/
Measure 321. Basic services for the economy and rural population	
Focus	Construction or reconstruction biogas production installation and plant using biomass/biogas (excluding places with more than 5,000 inhabitants)
Target groups	Community or organizational unit with organizer as a territorial self-government unit
Amount of subsidy / links	▪ Up to 75% of the total investment cost up to PLN 3 mln ▪ Overview: http://prow.rolnicy.com/podstawowe-usl.-dla-gosp.-i-ludnosci-wiejskiej/
Measure 312. Creation and development of microenterprises	
Focus	Investments connected with creation and development of microenterprises operating within the range of biogas generation from agricultural products and energy generation from biomass (excluding places with more than 5,000 inhabitants)
Target groups	E.g. natural person, legal person leading or undertaking economic activity as micro enterprise[6]
Amount of subsidy / links	▪ Up to 50% of the total investment cost ▪ Up to PLN 100,000, if it is expected to create 1 job position ▪ Up to PLN 200,000, if it is expected to create 2 job positions ▪ Up to PLN 300,000, if it is expected to create min. 2 job positions ▪ Overview: http://prow.rolnicy.com/tworzenie-i-rozwoj-mikroprzedsiebiorstw/

Financial support mechanism during operation rely on property rights for certificates issued under certificates of origin for energy, presented in the table below.

Table 36: Overview of polish act of parliament energy law

Act of Parliament Energy Law	
Focus	Energy Law rules: ▪ the priority purchase, transmission, distribution of and payment for electricity and heat from renewable energy sources by the grid system operators ▪ the nationwide equalisation scheme for the quantity of electricity purchased and paid for
Target groups	Operators of plants which provide electricity/heat/biogas from renewables (e.g. from biomass) to the grid system
Content/ How regulation works	Mechanism of subsidies, i.e. certificates of origin for energy, for biomass plants which provide electricity to the grid (e.g. biogas plants) rests on: for every produced (not necessary sold) MWh electric energy the certificate of origin for energy is issued. Then the property rights is sold, what generates income. There are following types of certificates of origin of energy in Poland: ▪ from renewable energy source (customary named as green certificates) – support lasts to the end of 2017 ▪ from high-efficiency cogeneration for electric power under 1 MW (yellow certificates) – support lasts to the end of 2012 ▪ from high-efficiency cogeneration from biogas (violet certificates) – support lasts to the end of 2018 ▪ from high-efficiency cogeneration from the rest of fuels and plants of electric power min. 1 MW (red certificates) – support lasts to the end of 2012 ▪ of agricultural biogas next putting into distribution network (brown certificates) – support lasts to the end of 2019 (legal acts has not been introduced yet, so in fact the mechanism is not operating yet). The amount of produced biogas will be counted over on the basis of lower heating value into equivalent amount of electricity coming from renewable energy sources according to the formular: $$E = M \cdot r \cdot \frac{0{,}42}{3600}\ [MWh]$$ M: the amount of produced biogas in m³ r: lower heating value in MJ/m³ 0,42: so far this value has been merely proposed mean efficiency of electric energy generation in renewable source

Act of Parliament Energy Law	
Detailed Amount of subsidy / Links	Below possible cases with achieved incomes from certificates of origin sale are enumerated: ▪ electricity coming from biomass or biogas – green certificates – 283 PLN/MWh ▪ electricity production in high-efficiency cogeneration from biomass – green + red certificates – 283 PLN/MWh + 9 PLN/MWh = 292 PLN/MWh ▪ electricity production in high-efficiency cogeneration from biogas in plants of electric power below 1 MW – green + yellow certificates – 283 PLN/MWh + 126 PLN/MWh = 409 PLN/MWh ▪ electricity production in high-efficiency cogeneration from biogas in plants of electric power min. 1 MW – green + violet certificates – 283 PLN/MWh + 58 PLN/MWh = 341 PLN/MWh ▪ agricultural biogas production and putting into distribution network – brown certificates – 283 PLN/MWh The value of certificates of origin for energy partially is subject to marketable mechanisms and is changing during time, see: http://wyniki.tge.pl/wyniki/rpm/ For general information on Energy Law see: http://isap.sejm.gov.pl/DetailsServlet?id=WDU19970540348
Comments	Please note: subsidies will be changed after introducing Act on Renewable Energy Sources which proposes correction factors for certificates of origin for energy from different type of sources. For general information see: http://legislacja.rcl.gov.pl/lista/2/projekt/19349

3.4.7. The Netherlands

In the Netherlands there are different types of subsidies for sustainable energy. The most important subsidy is an exploitation subsidy called SDE+.

3.4.7.1. SDE+ SUBSIDY

The SDE+ subsidy includes besides biomass all different kind of sustainable energy like geothermal, waste incineration, solar energy, wind energy etc. The SDE+ subsidy aims to pay the difference between the cost price of bio-energy and the market price of regular energy. Yearly the costs are calculated by ECN (Energy Research Centre Netherlands) and based on these costs the basic fees for delivered heat, electricity or bio-methane are determined. In case the subsidy is granted, the difference between the basic fee and the market price will be paid by the government for 12 years.

The SDE subsidy works with a fixed budget which can be different per year. In 2014 and 2015 the total budget was 3.5 billion €. The subsidy is from 2015 divided in 9 separate phases which open on different dates. The technologies which need the lowest amount of subsidy can request the subsidy in the first phases. In case the total budget is divided, new request cannot be granted. In that case you have to wait till the next year. In previous year it happens often that the budget was reached in the first phase. On the contrary, in 2014 the last phase was opened-up. Before a request for the SDE subsidy can be handed in the project needs to have all necessary permits and an agreement with the land over.

For 2015 mono-manure digestion category heat reach the highest subsidy already in phase 5 (out of 9), with a value of €0.106/kWh. Production of greengas and CHP has it highest value in phase 9, for CHP €0.15/kWh and for greengas €0.118/kWh.

For more information regarding the SDE please see http://www.rvo.nl/subsidies-regelingen/stimulering-duurzame-energieproductie-sde.

3.4.7.2. EIA AND MIA

The EIA (energy investment reduction) and MIA (environment investment reduction) are both tax regulations in which a percentage of the investment can be additionally used to lower the taxable profit of the organization. In this way less tax needs to be paid. Every year a list is created by RVO in which the installations which can use the EIA or MIA regulation are summed up.

At this moment no biogas-related investments are on that list.

3.4.7.3. VAMIL

The VAMIL is closely related to MIA and can be used to depreciate the investment at an own chosen moment. In this way tax can be slightly reduced. Also the VAMIL works with a list of applicable investments. Also on this list are nowadays no relevant investments.

3.4.7.4. INVESTMENT SUBSIDIES

Some provinces like Overijssel offer additional investment subsidies for especially small scale digesters. It's always wise to check the website of your province, region to see if additional subsidies are available.

For manure treatment there are sometimes tenders, initiated by RVO, by which manure treatment installations like separators can be subsidized. Those are usually only a few months open for subscription. Information can be found on the website of RVO, www.rvo.nl.

3.5. Further information (publications)

Common literature and reliable information which are available in the particular country about agricultural biogas plants and / or about small scale biogas plants so as further technologies.

3.5.1. Belgium

Literature and publications with information about agricultural biogas plants in Belgium

Voortgangsrapport Biogas-E 2014	Publisher: Biogas-e, 2014, 43 pages Download: http://www.biogas-e.be/node/349

3.5.2. Denmark

Literature and publications with information about agricultural biogas plants in Denmark

Biogas og økologisk landbrug - en god cocktail	Publisher: Dansk Landbrugsrådgivning, 12 pages, 2010 Download: https://www.landbrugsinfo.dk/Oekologi/biogas/Filer/erf_101130_bigas_pdf.pdf
Biogasanlag - bidrager til et baredygtigt landbrug	Publisher: Dansk Landbrugsrådgivning, 2012 Shop: http://netbutikken.vfl.dk/products/productlist.aspx?Searchtext=biogasanl%C3%A6g
Biogaspjece	Publisher: Naturstyrelsen, 2011 Download: http://naturstyrelsen.dk/
Alternative drivmidler	Publisher: Energistyrelsen, 2012, ISBN 978-87-7844-923-8 Download: http://www.biogasbranchen.dk/Viden/Rapporter/Alternative_drivmidler.aspx

3.5.3. France

Literature and publications about agricultural biogas plants and further technologies in France

2012-11 Guide réglementaire méthanisation & compostage	Publisher: ADEME Year of publication: November 2012 No. of pages : 83 Online product: http://www.ademe.fr/cadre-reglementaire-juridique-activites-agricoles-methanisation-compostage
Guide pratique pour les projets d'une puissance électrique inférieure à 500 kWe	Publisher: ADEME Year of publication: 2011 No. of pages: 19 Online product: http://www.ademe.fr/methanisation-a-ferme-guide-pratique-projets-dune-puissance-electrique-inferieure-a-500-kwe
Fiche Technique Méthanisation	Publisher: ADEME Year of publication: February 2014 No. of pages : 19 Online product: http://www.ademe.fr/sites/default/files/assets/documents/expertsie_dechets_-_fiche_technique_methanisation.pdf

3.5.4. Germany

Literature and publications about agricultural biogas plants and further technologies in Germany

Leitfaden Biogas Von der Gewinnung zur Nutzung	Publisher: Fachagentur Nachwachsende Rohstoffe, 6. Auflage, 2013, 244 Seiten, ISBN: 3-00-014333-5 Download: http://mediathek.fnr.de/broschuren/bioenergie/biogas.html
Faustzahlen Biogas	Publisher: Kuratorium für Technik und Bauwesen in der Landwirtschaft, 3. überarbeitete Auflage, 2013, 360 Seiten, ISBN 978-3-941583-85-6 Shop: https://www.ktbl.de/shop/
Biogas Praxis Grundlagen, Planung, Anlagenbau, Beispiele, Wirtschaftlichkeit	Author: B. Eder, et. al., 5. überarbeitete Auflage 2012, 254 Seiten, ökobuch Verlag, ISBN: 978-3-936896-60-2
Biogashandbuch Bayern Materialienband	Publisher: Bayerisches Landesamt für Umwelt Stand 2014 Download: http://www.lfu.bayern.de/energie/biogashandbuch/index.htm
Schwachstellen an Biogasanlagen verstehen und vermeiden	Publisher: Kuratorium für Technik und Bauwesen in der Landwirtschaft, 2. überarbeitete Auflage, 2009, 56 Seiten, ISBN 978-3-939371-81-6 Shop: https://www.ktbl.de/shop/
Sicherer Betrieb von Biogasanlagen Gesetzliche Normen praktisch umsetzen	Author: D. Walter, 1. Auflage, 2013, 120 Seiten, DLG-Verlag, ISBN 978-3-7690-2023-6
Biomethaneinspeisung in der Landwirtschaft Geschäftsmodelle - Technik - Wirtschaftlichkeit	Publisher: Kuratorium für Technik und Bauwesen in der Landwirtschaft, 1. Auflage, 2012, 84 Seiten, ISBN 978-3-941583-70-2 Shop: https://www.ktbl.de/shop/
Leitfaden Biogasaufbereitung und -einspeisung	Publisher: Fachagentur Nachwachsende Rohstoffe, 5. überarbeitete Auflage, 2014, 160 Seiten, ISBN 3-00-018346-9 Download: http://mediathek.fnr.de/leitfaden-biogasaufbereitung.html
Biogas from Waste and Renewable Resources An Introduction	Author: D. Deublein, A. Steinhauser, 2., überarbeitete Auflage, 2010, 550 Seiten, Wiley-VCH Verlag, ISBN 978-3-527-32798-0
Biogas-Messprogramm II - 61 Biogasanlagen im Vergleich	Publisher: Fachagentur Nachwachsende Rohstoffe, 2009, 168 Seiten, ISBN 978-3-9803927-8-5 Download: http://www.fnr-server.de/ftp/pdf/literatur/pdf_385-messprogramm_ii.html
Clevere Landwirte geben Gas Musterlösungen zukunftsfähiger Biogasanlagen	Publisher: Kuratorium für Technik und Bauwesen in der Landwirtschaft, 1. Auflage, 2012, 48 Seiten, ISBN 978-3-941583-69-6 Shop: https://www.ktbl.de/shop/
Festmist- und Jaucheanfall	Publisher: Kuratorium für Technik und Bauwesen in der Landwirtschaft, Schrift 502, 1. Auflage, 2014, 72 Seiten, ISBN 978-3-941583-68-9 Shop: https://www.ktbl.de/shop/
Technologiebewertung von Gärrestbehandlungs- und Verwertungskonzepten	Author: W. Fuchs, B. Drosg; Publisher: Universität für Bodenkultur Wien, 1. Auflage 2010, 215 Seiten, ISBN: 978-3-900962-86-9

3.5.5. Italy

Publications about agricultural and/or small scale biogas plants

Biogas Handbook	Publisher: University of Southern Denmark Esbjerg, 2008, 126 pages, ISBN: 978-87-992962-0-0 Download: http://www.big-east.eu/downloads/IR-reports/ANNEX%202-39_WP4_D4.1_Master-Handbook.pdf
Biogas developement in developing countries - A methodological guide for domestic biogas project holders in the early stages of setting up projects in developing countries	Publisher: ENEA Consulting, 2013, 25 pages. Download: http://www.enea-consulting.com/wp-content/uploads/Open-Ideas-Domestic-biogas-projects-in-developing-countries.pdf
Bioslurry = Brown Gold? In "A review of scientific literature on the co-products of biogas production"	Publisher: FAO, 2013, 45 pages, ISBN: 978-92-5-107929-4 Download: http://www.fao.org/3/a-i3441e.pdf
Energia dal biogas	Publisher: Associazione Italiana Energie Ambientali, 2008, 103 pages. Download: http://www.crpa.it/nqcontent.cfm?a_id=3722&tt=crpa_www

3.5.6. Poland

Publications about agricultural and small scale biogas plants

Mała Biogazownia Rolnicza	Publisher: Fundacja Instytut na rzecz Ekorozwoju, 2011, 32 pages, ISBN: 978-83-89495-06-8 Download: http://www.ine-isd.org.pl/theme/UploadFiles/File/publikacje/broszury/1_biogazownia_rolnicza_screen.pdf
Przewodnik dla inwestorów zainteresowanych budową biogazowni rolniczych	Publisher: Ministry of Economy, 2011, 126 pages Download: http://www.mg.gov.pl/files/upload/13229/poranik%20biogazowy.pdf
Budowa i eksploatacja biogazowni rolniczych - Poradnik dla inwestorów zainteresowanych budową biogazowni rolniczych	Publisher: Instytut Technologiczno-Przyrodniczy, 2011, 142 pages, ISBN: 978-83-62416-23-3 Download: http://www.lgdziemiminskiej.pl/dobrepraktyki/6.pdf

3.5.7. The Netherlands

Publication about agricultural biogas plants in The Netherlands

Benodigde vergunningen voor biogasproductie-installaties	Stichting Groen Gas Nederland, 2013, 7 pages

3.6. Contacts for information and consulting

3.6.1. Belgium

Biogas-E vzw	Address: Phone: E-Mail: Web:	Graaf Karel de Goedelaan 34 8500 Kortrijk / Belgium +32(0) 56 241 26 3 info@biogas-e.be http://www.biogas-e.be
Vlaams Landmaatschappij	Address: Phone: Web:	Gulden-Vlieslaan 72 1060 Saint-Gilles / Belgium +32(0) 25 43 72 00 http://www.vlm.be
Vlaamse Milieumaatschappij	Address: Phone: E-Mail: Web:	A. Van de Maelestraat 96 9320 Erembodegem / Belgium +32(0) 53 72 64 45 info@vmm.be http://www.vmm.be
Vlaamse Regulator van de Elektriciteits- en Gasmarkt	Address: Phone: E-Mail: Web:	Graaf de Ferrarisgebouw Koning Albert II-laan 20 bus 19 1000 Brussels / Belgium +32 (0) 25 53 17 00 info@vreg.be http://www.vreg.be
Boerenbond en Landelijke Gilden	Address: Phone: E-Mail: Web:	Diestsevest 40 3000 Leuven / Belgium +32 (0) 16 28 60 00 info@boerenbond.be https://www.boerenbond.be
Innovatiesteunpunt VZW	Address: Phone: E-Mail: Web:	Diestsevest 40 3000 Leuven / Belgium +32 (0)16 28 61 27 energie@innovatiesteunpunt.be https://www.innovatiesteunpunt.be

3.6.2. Denmark

AgroTech A/S	Address: Phone: E-Mail: Web:	Agro Food Park 15 8200 Århus N +45 8743 8400 agrotech@agrotech.dk www.agrotech.dk
Økologisk landsforening	Address: Phone: E-Mail: Web:	Silkeborgvej 260 8230 Åbyhøj +45 8732 2700 info@okologi.dk http://www.okologi.dk/
Gosmer Biogas	Address: Phone: E-Mail: Web:	Gosmervej 56 8300 Odder +45 8655 4033 hp@gosmer-biogas.dk http://www.gosmer-biogas.dk/
Lundsby Bioenergi	Address: Phone: E-Mail: Web:	Nørrevangen 18 9631 Gedsted +45 5125 0942 info@lundsby.dk http://www.lundsby.dk

3.6.3. France

ADEME - Agence de l'environnement et de la maîtrise de l'énergie Agency for Environment and Energy Management	Address: Phone: Fax: E-Mail: Web:	20 avenue du Grésillé BP 90406 49004 ANGERS cedex1 02 41 20 41 20 02 41 87 23 50 ademe.paysdelaloire@ademe.fr www.ademe.fr
Ministère de l'Agriculture de l'Agroalimentaire et de la Forêt Ministry of Agriculture, Agri food and Forestry	Address: Phone: Web:	78 r Varenne 75007 PARIS 01 49 55 49 55 http://agriculture.gouv.fr/Plan-Energie-Methanisation http://agriculture.gouv.fr/methanisation-definition
Ministère de l'Ecologie, du développement Durable et de l'Energie Ministry for ecology and sustainable development and Energy	Address: Phone: Web:	Hotel De Roquelaure 246 bd St Germain 75007 PARIS 01 40 81 21 22 www.developpement-durable.gouv.fr/-Biogaz,416-.html
Agricultural Chambers	Address: Phone: Fax: E-Mail: Web:	9 Avenue George V 75008 Paris 01 53 57 10 10 01 53 57 10 05 accueil@apca.chambagri.fr www.chambres-agriculture.fr
AAMF/TRAME Association of the AD plant Farmers of France	Address: Phone: Fax: E-Mail: Web:	6 rue de la Rochefoucauld 75009 PARIS 01 44 95 08 00 01 40 74 03 02 aamf@trame.org www.pardessuslahaie.net/agriculteurs-methaniseurs
ATEE Club Biogaz	Address: Phone: Fax: Web:	47 avenue Laplace 94117 Arcueil cedex 01 46 56 91 43 01 49 85 06 27 www.atee.fr/biogaz

3.6.4. Germany

IBBK Fachgruppe Biogas GmbH *International Biogas & Bioenergy Centre of Competence*	Address: Phone: E-Mail: Web:	Am Feuersee 6 74592 Kirchberg/Jagst / Germany +49 (0)7954 9262-03 info@biogas-zentrum.de www.biogas-zentrum.de
Kuratorium für Technik und Bauwesen in der Landwirtschaft e.V. (KTBL) *Association for Technology and Structures in Agriculture*	Address: Phone: E-Mail: Web:	Bartningstraße 49 64289 Darmstadt / Germany +49 (0)6151 7001-0 info@ktbl.de www.ktbl.de
Centrales Agrar-Rohstoff-Marketing- und Energie-Netzwerk e.V. (C.A.R.M.E.N)	Address: Phone: E-Mail: Web:	Schulgasse 18 94315 Straubing / Germany +49 (0)9421 960-300 contact@carmen-ev.de www.carmen-ev.de/biogas
Deutsches BiomasseForschungsZentrum gGmbH (DBFZ) *German Biomass Research Center*	Address: Phone: E-Mail: Web:	Torgauer Str. 116 04347 Leipzig / Germany +49 (0)341 2434-112 info@dbfz.de www.dbfz.de
Fachagentur Nachwachsende Rohstoffe e.V. (FNR) *Agency for Renewable Resources*	Address: Phone: E-Mail: Web:	OT Gülzow Hofplatz 1 18276 Gülzow-Prüzen / Germany +49 (0)3843 6930-199 info@bio-energie.de www.bio-energie.de
Fachverband Biogas e.V. *German Biogas Association*	Address: Phone: E-Mail: Web:	Angerbrunnenstrasse 12 85356 Freising / Germany +49 (0)8161 9846-60 info@biogas.org www.biogas.org

3.6.5. Italy

Associazione Italiana di Tecnologia Alimentare (AITA)	Web:	http://www.aita-nazionale.it
Chimica verde	Web:	http://www.chimicaverde.net
Consorzio Italiano Biogas e Gassificazione (CIB)	Web:	http://www.consorziobiogas.it
Consorzio Monviso Energia	Web:	http://www.monvisoenergia.it
Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile (ENEA)	Web:	http://www.enea.it
Gestore servizi energetici (GSE)	Web:	http://www.gse.it
Legambiente	Web:	http://www.legambiente.it
Unione Nazionale Comuni Comunità Enti Montani (UNCEM)	Web:	http://www.uncem.it
Sportello Fonti rinnovabili	Web:	http://www.fonti-rinnovabili.it
Il Portale italiano delle Energie Rinnovabili	Web:	http://www.energie-rinnovabili.net/
Ministero dell' ambiente	Web:	http://www.minambiente.it
Ministero delle politiche agricole alimentari e forestali (MIPAAF)	Web:	http://www.politicheagricole.it
Unione delle province d'Italia (UPI)	Web:	http://www.upinet.it/

3.6.6. Poland

Center for Information about the Energy Market (CIRE)	E-Mail: Web:	cire@cire.pl http://www.cire.pl
Energy Conservation Foundation (FPE)	E-Mail: Web:	biuro@fpe.org.pl http://www.fpe.org.pl
Energy Regulatory Office (URE)	E-Mail: Web:	ure@ure.gov.pl http://www.ure.gov.pl
Environmental Information Center (CIoS)	E-Mail: Web:	centrum@cios.gov.pl http://www.ekoportal.gov.pl
Institute for Renewable Energy (EC BREC IEO)	E-Mail: Web:	biuro@ieo.pl http://www.ieo.pl
National Energy Conservation Agency (NAPE)	E-Mail: Web:	nape@nape.pl http://www.nape.pl
Polish Biogas Association (PBA)	E-Mail: Web:	info@pba.org.pl http://www.pba.org.pl
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Stichting Groen Gas Nederland	E-Mail: Web:	info@groengas.nl www.groengas.nl

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